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Occurrence of Pathogens in Distribution and Marketing Municipal Sludges

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16. ABSTRACT

A study of the occurrence of indicator and pathogenic microorganisms in distributed and marketed municipal sewage sludges was conducted. Samples were analyzed for a variety of bacteria, viruses, parasites, and fungi. In the first part of this study, seven municipal sewage sludge compost products were sampled weekly for one year. Five of the products originated from a windrow composting facility and two products originated from an aerated static pile composting facility. The indicator organisms were frequently detected at high and variable concentrations. The only potential pathogens detected regularly were bacterial. Helminth ova were detected but none could be shown to be viable. Enteric viruses were confirmed in only two samples, one each from the static pile and windrow locations. The potential bacterial pathogens detected were salmonella and *Yersinia*. Salmonellae were detected at both facilities. *Yersinia* only occurred significantly at the static pile facility and were isolated in a pattern consistent with a seasonal occurrence. At the windrow facility, salmonellae were primarily isolated from amended compost products. Toxigenic *E. coli* were randomly isolated. Total and fecal coliforms and fecal streptococci were shown to be good predictors of the presence of salmonellae. In the second part of the study, 24 additional municipalities were sampled bi-monthly. Sludge products included composts, air-dried, and heat-treated sludges. Results from the 24 facilities also showed considerable variation in microbial densities. Air-dried sludges often contained lower concentrations of enteric bacteria than composted sludges and as a group, were significantly lower than static pile composting sites. Salmonellae, *Yersinia* and toxigenic *E. coli* were randomly isolated, generally at low levels. This study disclosed essentially no hazard from parasites or viruses in treated sludges. A potential health hazard associated with salmonellae was detected at both facilities sampled weekly. The significance of *Yersinia* populations at the static pile facility was uncertain. Results from the windrow facility indicated that significant increases in bacterial populations, including salmonellae, occurred during subsequent production of commercial soil amendment products. These increases were consistent with a regrowth phenomenon.

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FOREWORD

The many benefits of our modern, developing, industrial society are accompanied by certain hazards. Careful assessment of the relative risk of existing and new man-made environmental hazards is necessary for the establishment of sound regulatory policy. These regulations serve to enhance the quality of our environment in order to promote the public health and welfare and the productive capacity of our Nation's population.

The complexities of environmental problems originate in the deep interdependent relationships between the various physical and biological segments of man's natural and social world. Solutions to these environmental problems require an integrated program of research and development using input from a number of disciplines. The Health Effects Research Laboratory, Research Triangle Park, North Carolina, and Cincinnati, Ohio, conducts a coordinated environmental health research program in toxicology, epidemiology, and clinical studies using human volunteer subjects. Wide ranges of pollutants known or suspected to cause health problems are studied. The research focuses on air pollutants, water pollutants, toxic substances, hazardous wastes, pesticides and nonionizing radiation. The laboratory participates in the development and revision of air and water quality criteria and health assessment documents on pollutants for which regulatory actions are being considered. Direct support to the regulatory function of the Agency is provided in the form of expert testimony and preparation of affidavits as well as expert advice to the Administrator to assure the adequacy of environmental regulatory decisions involving the protection of the health and welfare of all U.S. inhabitants.

This report describes the occurrence of microorganisms in distributed and marketed municipal wastewater sludges. These data may be useful in evaluating the potential health risk from use of such products and in developing criteria for the safe disposal of municipal sewage sludges.

F. Gordon Hueter, Ph.D
Director
Health Effects Research Laboratory

ABSTRACT

A study of the occurrence of microorganisms in distributed and marketed municipal sewage sludges was conducted in order to determine the levels of indicator and pathogenic organisms that might be present in these products. Samples were analyzed for a variety of bacteria, viruses, parasites and fungi in the indicator and pathogen categories. In the first part of this study, seven municipal sewage sludge compost products were sampled weekly for one year. Five of the sample products originated from one windrow composting facility and two products originated from one aerated static pile composting facility.

The products sampled at the windrow facility included the final compost produced at the municipal composting facility, and four commercially marketed, compost based soil amendment products. The two sampling points at the static pile facility were the final screened compost which was utilized in a number of bulk distribution programs and the "giveaway bin" which contained unscreened compost available to the public for home use.

The indicator microorganisms were frequently detected at high concentrations. Tremendous indicator variability was observed with some concentrations varying by as much as ten orders of magnitude. Data from the windrow site grouped into two strata. The first stratum included the final compost and the commercial product containing only screened final compost. Average concentrations of organisms were higher in the bagged compost than in the field compost samples but the differences were not significant at the 95% confidence limits (C.L.). The second grouping of data consisted of bagged commercial products containing additional amendments; these products contained significantly higher concentrations of microorganisms than those in the first stratum.

Analysis of the indicator data from the static pile composting facility indicated that these two sampling points were also significantly different. The screened compost contained higher levels of bacteria than the material in the giveaway bin.

The only potential pathogens detected with regularity were bacterial. No protozoan cysts were found. Helminth ova were regularly detected but none could be shown to be viable. The most common ova observed were Trichuris and Ascaris. Many of the Trichuris were probably of non-human origin. Enteric viruses were confirmed in only two samples at very low levels.

The potential bacterial pathogens regularly detected were Salmonella and Yersinia. Salmonellae were detected at both facilities. Yersinia only occurred significantly at the static pile facility and were isolated in a pattern consistent with a seasonal occurrence. At the windrow facility, salmonellae were primarily isolated from amended compost products. Toxigenic E. coli were randomly isolated. No Campylobacter were detected.

Total and fecal coliforms and fecal streptococci were shown to be good predictors of the presence of salmonellae.

In the second part of the study, 24 additional municipalities were sampled bimonthly for pathogen and indicator microorganism determinations. Final sludge products included composts, air-dried sludges and heat-treated sludges. Results from the 24 facilities also showed a great deal of variation in microbial densities. Air dried sludges often contained lower concentrations of enteric bacteria than composted sludges and as a group, were significantly lower than static pile composting sites. Salmonellae, Yersinia and toxigenic E. coli were randomly isolated, generally at low levels.

This study disclosed essentially no hazard associated with treated sludges from parasites or viruses. A potential health hazard associated with salmonellae was detected at both facilities sampled weekly. Results indicated that current composting practices may not insure complete elimination of pathogenic bacteria. The significance of Yersinia populations at the static pile facility was uncertain but isolation patterns suggested a seasonal occurrence. Relatively few salmonellae were detected in final compost from the windrow facility but significant increases in bacterial populations, including salmonellae, occurred during subsequent production of commercial soil amendment products. These increases were consistent with a regrowth phenomenon. Conventional indicator organisms appeared to be reasonable predictors for the presence of salmonellae. Final sludge products derived from the various treatment processes often did not contain detectable levels of the tested enteric pathogens but the data suggest monitoring may be necessary to insure consistent quality of sludge based products destined for home use.

This study was conducted by the County Sanitation Districts of Los Angeles County, Whittier, California. This report was submitted in fullfillment of CR-812589 by the County Sanitation Districts of Los Angeles County under primary sponsorship of the U.S. Environmental Protection Agency. This report covers field and laboratory activities performed from July 1, 1985 to August 7, 1987; work was completed as of August 31, 1987.

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SECTION 1

INTRODUCTION

The Clean Water Act of 1972 (PL 92-500) was enacted to improve the quality of the nation's water supplies. As a result, a by-product of sewage treatment, known as sludge, has increased in quantity as wastewater treatment improved and expanded. An estimated 7 to 9 million dry tons of sludge are produced annually, and this amount is predicted to increase significantly in the future (Ward *et al* 1984). Disposal of this sludge has become a major function of publicly owned treatment works (POTW); disposal options, however, are often limited. Ocean disposal of sludge has been greatly reduced. Cost and air pollution considerations have curtailed the use of incineration, and transportation costs and the lack of available sites have lessened the popularity of landfilling as sludge disposal options (Ward *et al* 1984).

An attractive alternative, rapidly gaining in popularity, is the beneficial use of sludge as a soil amendment. Sludge has been shown to be an excellent organic amendment for soils; it is also a source of nutrients and minerals for plants. Land application of sludge represents a significant and rapidly increasing option for disposal of sludge produced in the U.S. (Page *et al* 1983).

EPA has promulgated regulations (40 CFR 257) specifying acceptable sludge treatments depending on the ultimate use of the sludge and the amount of public exposure. These treatments are termed Processes to Significantly Reduce Pathogens (PSRP) and Processes to Further Reduce Pathogens (PFRP). PSRP are generally standard treatment processes that incidentally reduce pathogens, such as anaerobic digestion. PFRP are processes specifically intended to reduce pathogens, as well as provide sludge stabilization, such as high temperature composting. Various restrictions are placed on the land disposal of sludges that have received only a PSRP treatment. Under current guidelines, a sludge subjected to PSRP followed by a PFRP may be used without restrictions.

Although the use of sludge as a soil amendment is attractive, it is not without potential health risks. Toxic chemicals, including heavy metals and industrial organics, may enter the food chain and present long term health risks. Pathogenic microorganisms present in sewage and the resulting sludges increase the potential for disease transmission. These concerns must be mitigated if the full resource potential of sludge is to be realized.

In many areas, toxic chemicals are not present or their levels may be reduced to acceptable levels through source control programs. Pathogenic microorganisms, however, enter the wastewater from infected individuals. These organisms often concentrate in the resulting sludges due to their density or through adsorption to larger particles. The pathogens are thus a normal component of sludge and cannot be reduced by source control. The treatment processes employed at the POTW must effectively eliminate, or reduce to acceptable levels, the pathogenic microorganisms present in sludge before the material can be released for use.

The relative public health risk associated with the beneficial use of sludge is directly related to the extent of public exposure. Agricultural use for feed crops and silviculture in limited access areas present minimal risks. Risk increases if the sludge is used on food chain crops or public access areas.

Many programs are currently distributing and marketing (D & M) PFRP treated sludges for home use on lawns and ornamental and vegetable gardens (Goldstein 1983). Of the various reuse options, home use of treated sludge via some form of marketing or distribution program would appear to present the greatest potential for significant health effects due to increased exposure. The routes of exposure may take various forms, including hand work in gardens, and eating uncooked vegetables grown in sludge amended soils. Perhaps at the highest risk of ingesting pathogenic organisms are very young children who have not yet developed common sense hygienic habits playing in yards and gardens that have been treated with sludge products.

A number of review articles have discussed the occurrence and significance of pathogens in sewage and sludge and the effectiveness of various treatment options (Ward _et al_ 1984, Gerba 1983, Kowal 1983, Sepp 1980, Akin _et al_ 1977). Ward _et al_ (1984) considered the possibility of pathogen regrowth following PSRP and PFRP treatment. Some pathogenic or potentially pathogenic microorganisms have been shown to regrow in treated sludges, but the significance of this phenomenon has not been determined (Brandon _et al_ 1977, Russ and Yanko 1981, Hussong _et al_ 1985). Perhaps the most comprehensive discussion of microorganisms and disease associated with waste disposal is that published by Feachem _et al_, (1983). The pathogenic microorganisms of concern in sewage and sludge are members of four basic groups; these are the bacteria, fungi, parasites, and viruses.

Many different bacterial pathogens may be present in sewage and sludge. Kowal (1983) separated these into pathogenic bacteria (1) of major concern and (2) of minor concern. In the major concern category, he included _E. coli_ (pathogenic strains), _Salmonella_ sp., _Campylobacter jejuni_, _Yersinia enterocolitica_, _Leptospira_ spp., _Shigella_ spp., and _Vibrio cholerae_.

The pathogenic strains of *E. coli* are often the cause of "travelers diarrhea" and may cause serious gastroenteritis and diarrhea in children under five years of age (Geldreich, 1972). They have also been involved in outbreaks of gastroenteritis resulting from contaminated water supplies (Geldreich 1972). Three types of pathogenic *E. coli* have been recognized; they are enterotoxigenic, enteropathogenic and enteroinvasive (WHO 1980). It has been estimated that pathogenic *E. coli* represent less than 1% of the fecal coliform population (Geldreich 1972). Little is known about the occurrence or fate of enteropathogenic *E. coli* in sludge and sludge treatment processes. The potential for pathogenic *E. coli* regrowth in sludge products is unknown, but certainly possible.

In contrast to the paucity of data concerning pathogenic *E. coli* in sludges, the salmonellae have been widely studied. The previously cited reviews summarize much of this work. It has been estimated that up to 2 million people per year acquire *Salmonella* infections and the rate has been increasing in recent years (Gerba 1983.). For this reason one of the prime concerns cited by Ward *et al* (1984) is the potential for salmonellae regrowth.

Studies by Brandon (1977) and Yeager and Ward (1981) found that salmonellae would grow to high levels in sterilized sludge. Other experiments (Russ and Yanko 1981) demonstrated regrowth of indigenous salmonellae within the naturally occurring mixed microbial population of compost. Although the salmonellae increased more than three orders of magnitude within five days, the effect was transient and the salmonellae were returning to background levels after three weeks. Hussong (1985) studied this phenomenon in detail and concluded that the active microflora of moist compost would eliminate contaminating salmonellae after six weeks. Ward *et al* (1984) concluded that once a sludge product is applied to the soil, regrowth would not likely be a problem.

Nevertheless, the salmonellae remain an important concern with home use of sludge products. Most authorities indicate that a fairly high infective dose is required to initiate a *Salmonella* infection (Kowal 1983) but there is evidence that this may be an overgeneralization. D'Aoust and Pivnick (1976) and Lipson (1976) describe salmonellosis outbreaks that may have been initiated by infective doses as low as 10-100 cells. It would certainly appear imprudent to overlook moderate salmonellae populations because of "conventional wisdom" concerning infective doses.

Campylobacter and *Yersinia* have been referred to as "pathogens of emerging significance". Although much work has focused on *Yersinia* (Swaminathan *et al* 1982), there is very little information concerning these organisms in sludges. Dudley *et al* (1980) reported 2 X 10^5 *Yersinia enterocolitica* per gram total suspended solids in one digested sludge sample. A study in Seattle (Metro 1983) reported *Yersinia enterocolitica* levels of 10^7 to

10^9 per gram in various sludge samples. The significance of these numbers is unknown. Many Y. enterocolitica-like organisms, unusual Y. enterocolitica or atypical Y. enterocolitica have been reported (Swaminathan, 1982). The pathogenicity of individual strains is unknown and the role of these organisms in human disease has not been completely discerned. Kowal (1983) indicated yersiniosis occurs only sporadically in the United States.

Gastroenteritis caused by Campylobacter jejuni is much more common than previously thought and may approach the incidence of salmonellosis (Blaser and Roman 1981). C. jejuni is commonly found in the intestines of many animals (Blaser et al 1980a), but the fate of these organisms in the environment is generally unknown. Waterborne campylobacteriosis has been documented (Vogt et al 1982 and Metznig 1981) and the survival of the organisms in water has been studied to a limited extent (Blaser et al 1980b). Ottolenghi et al (1987) conducted limited experiments on the survival of Campylobacter in sludges from four wastewater treatment plants in Ohio. They found that seeded Campylobacter survived for seven days in sludge stored at 4 C, however, no indigenous Campylobacter were isolated from any sludge samples.

Although the other bacterial pathogens listed as significant by Kowal (1983) are responsible for a substantial amount of disease, they either have not been demonstrated in sludges (Ottolenghi et al 1987, Dudley et al 1980) or sludge applied to land is not considered an agent of transmission (WHO 1981).

A number of pathogenic or allergic fungi can be isolated from sludge. These include yeasts, such as certain species of Candida, Cryptococcus and Trichosporon, and pathogenic members of some filamentous genera such as Aspergillus, Phialophora, Geotrichum, Trichophyton and Epidermophyton (WHO 1981). Milner et al (1977) demonstrated that Aspergillus fumigatus, an opportunistic pathogen to individuals with pulmonary problems and a strong allergen to many, may proliferate in some composting systems. This may be a consideration when selecting prospective composting sites. The general consensus, however, is that fungi in treated sludges present a minimal hazard (WHO 1981). With the exception of the aspergilli, little work has been done to define the relationships of fungi in polluted environments or sludges. The significance, if any, of fungal types and diversity in compost is unknown. A highly diversified mycobiota probably indicates a stabilized environment. A lack of fungal diversity in treated sludge would not present a particular problem unless the fungus was potentially harmful. Dermatophytic fungi, for example, may be present in sludge at detectable levels. It is unknown if the common dermatophytes can survive or proliferate in sludges. Conventional thought considers the dermatophytes to be parasitic (Burrows 1968) although there is evidence that some dermatophytes live a saprophytic existence (Anjello 1958). Adding large numbers of these organisms to home soils would be undesirable.

Parasitic infections present a potential health risk associated with home use of sludge due to the existence of highly resistant stages of the organisms and low infective doses. Two groups of parasites are of concern, the protozoa and the helminths. The common protozoan parasites include organisms such as *Entamoeba histolytica* and *Giardia lamblia.* *Giardia* infection has become endemic in some areas of the country and numerous outbreaks of giardiasis have occurred (Craun 1979). *Ascaris* ova are the most commonly isolated nematode ova in sludge (Reimers *et al* 1981). Others include *Trichuris*, *Toxocara*, *Hymenolepis* and *Taenia,* to mention a few. In 1973, ascariasis was estimated to affect four million people in the United States (Kowal 1983).

Hays (1977) reviewed the potential for transmission of parasitic diseases with sludge. She indicated that sludge digestion destroyed protozoan cysts but not metazoan eggs. This observation was confirmed by recent studies in Seattle (Metro 1983) where *Giardia* was isolated from raw and waste activated sludges but not from digested or digested dewatered sludges. The Seattle study concluded that *Giardia* pose a negligible health risk from land application of digested sludges. In general, available evidence indicates that helminth ova are more resistant to environmental stresses than are protozoan cysts. The ova of *Ascaris sp*. are possibly the most resistant of the eggs or cysts commonly found in sewage (Brandon 1978). It has been proposed that *Ascaris* ova be used as an indicator of other parasites (Brandon 1978), however, the assessment of viability is important because intact non-viable ova may be detected. O'Donnell *et al* (1984) studied the inactivation rates of ova from three species of roundworms and a tapeworm when stored in sludges. Both viability and infectivity of the ova were evaluated. She concluded that long term storage may be an effective method of eliminating parasite eggs. A number of studies, as summarized by Feachem *et al* (1983) have shown that composting is an effective method of eliminating parasite ova. In this context, EPA permits unrestricted use of sludges subjected to PFRP treatment such as composting. The WHO (1981) concluded that the risk of infection to man from parasites associated with the use of (untreated) sludge needs evaluation.

More than 110 enteric viruses are recognized and may be present in sewage (Gerba 1983). The list of enteric viruses is increasing and now includes rotaviruses and the Norwalk viral agent (Gerba 1983). Most viruses probably adsorb to the solids in sewage although the adsorption process has been shown to be type-and strain-dependent (Gerba 1983). Yanko *et al* (1983) reviewed the potential for transmission of viral diseases through sludge reuse programs and concluded that a potential health hazard did exist. Virus data collected during a compost monitoring program (Yanko *et al* 1983) indicated that composting was an effective means of reducing viral levels. The results also suggested that the composting procedures must be well-defined, with monitoring or process assurances that all of the composting mass is exposed to adequate temperatures. If not properly controlled, virus survival could occur. Infective doses for the viruses are thought to be low (Kowal 1983). Therefore, reasonably thorough virus inactivation is necessary for home use of sludge products. Once destroyed, enteric viruses cannot re-establish themselves in sludge; regrowth is not a concern (Ward *et al* 1984).

Farrell (1986) and the WHO (1981) addressed the question of risk to health from use of sludge on land. Both concluded that appropriate measures are available to manage the risk. The WHO (1981) and a group of scientists meeting in Denver in 1983 (Page *et al* 1983) further pointed out that there appear to be no published records of adverse health effects on man assoicated with the land application of sludge.

The lack of information on health problems associated with D & M sludges may reflect the absence of a problem, the lack of intensive surveillance, or the inability to detect recurrent small-scale incidents of disease. In general, the levels of enteric disease in the U.S. are low because of good sanitation, personal hygiene, and extensive public treatment works. In recent years, however, waterborne outbreaks of disease and the rates of certain enteric diseases, such as salmonellosis, have been increasing.

OBJECTIVE OF THIS STUDY

The basic objective of this study was to determine the types and concentrations of various indicator and pathogenic microorganisms that may be present in distributed and marketed sludges. These data may be used to assess the potential health risk to the user and evaluate the need for additional criteria. An additional objective was to survey the presence of toxic chemicals in D & M sludges. The results of the chemical analyses appear in a separate report.

SECTION 2

CONCLUSIONS

All of the sewage sludge products examined were found to contain variable densities of indicator microorganisms. Some products contained bacterial pathogens at high frequencies and levels. Variability of microorganism concentrations was often great between different facilities and between different samples from the same facility. Many of the observed trends would not have been detected without a large number of samples collected over a long period of time.

Overall, the highest concentrations of microorganisms occurred in samples from static pile composting systems; the lowest concentrations were found in pelletized sludge from a heat drying process. Microorganism densities in aged anaerobically digested-air dried sludges were as low as, or lower, than most of the composted sludges.

Composts modified with various materials to produce commercial soil amendments contained significantly higher concentrations of bacteria and fungi than the base compost material. The data suggested a nutrient related regrowth phenomenon.

Potentially pathogenic bacteria, including Salmonella sp., Yersinia enterocolitica and toxigenic E. coli were detected. Salmonella sp. were the most frequent pathogen detected. The quantitative test for toxigenic E. coli indicated that these strains, when present, occurred at very low levels. However, the percentage of colonies that were toxigenic strongly suggested that the concentration of toxigenic strains was much higher than indicated. Yersinia enterocolitica occurred at very high densities in some samples. The isolation of Yersinia was consistent with a seasonal occurrence. The prevalence and density was higher in colder months. Based on a small number of tests the Yersinia appeared to be avirulent (not causing disease).

No significant health hazard was found associated with respect to Campylobacter, parasitic helminth ova or enteric viruses. The test for campylobacters in compost was relatively ineffective but other available data suggest these bacteria would not survive composting or air drying. Helminth ova were detected regularly but no indications of viability were observed. No protozoan cysts were found.

The fungus Aspergillus fumigatus was detected in products from most sample sites, but usually at low densities. The highest concentrations of A. fumigatus occurred in composts from static pile composting facilities.

Given the considerable variation observed in microbial densities and the reasonably frequent isolation of salmonellae, bacterial monitoring to assure product quality may be of value for the home use of sludge and compost soil amendments. Regression analysis suggested that total or fecal coliforms or fecal streptococci may be suitable indicators for monitoring.

The occurrence of pathogenic bacteria in distributed and marketed municipal sewage sludge products represents a potential health hazard. However, the extent of risk associated with use of such products remains to be determined.

SECTION 3

RECOMMENDATIONS

Factors associated with the extensive variability observed in the microbial populations need to be better delineated in order to institute appropriate control measures.

Significance of the relatively high microbial concentrations in static pile compost products should be determined. The influence of recycling wood chips should be further evaluated.

Additional studies on *Salmonella* regrowth are recommended. The effects of substrate additions should be evaluated. Laboratory regrowth experiments to date may not have adequately simulated field conditions.

Consideration should be given to establishing criteria and conducting research necessary for qualifying digested, air dried sludges as equivalent to PFRP treated sludges.

Further studies are recommended to quantitate toxigenic *E. coli* populations. Gene probe techniques may be applicable to this task.

The potential for sludge and compost to serve as a reservoir of pathogenic *Yersinia* in certain locations needs additional evaluation.

Bacterial limits may need to be established for the uncontrolled home use of sludge and compost products or appropriate educational material should be supplied to users of the products.

Studies should be conducted to determine the extent of risk, if any, of bacterial infections from the use of distributed and marketed municipal sewage sludge products.

SECTION 4.

EXPERIMENTAL PROCEDURES

PROJECT DESIGN

During the first phase of this project, a survey was conducted of prospective sites to include in the study. State sludge program coordinators were asked to recommend suitable sites in their states; suggestions were also obtained from other private and governmental organizations. Prospective facilities were sent a letter describing the study and were asked to complete a detailed questionnaire about their sewage and sludge treatment processes and sludge disposal practices. Municipalities participating in the project were selected from those responding based on a number of criteria. These included the sludge treatment process employed, the geographic and climatic region, and the existence of a distribution program. In some cases, a distribution program was planned, but not yet in operation. A small number of selected facilities did not operate a distribution program but were selected because they were representative of a specific treatment process or region. This study included some products distributed predominantly for agricultural purposes. Seventeen of the 26 facilities sampled during the study did specifically distribute or market some portion of final sludge product for home use. The overall sampling program was divided into three tasks designed to evaluate different aspects of the primary goal.

Weekly Sampling

The first task concentrated intensive sampling at each of two large composting facilities for microbiological testing. One sample per week was collected from each of seven sampling points for a period of one year. These facilities were designed to meet PFRP criteria.

One facility was located on the East Coast and utilized the "Beltsville" aerated static pile method of composting. Two sampling points were established at this facility. One sampling point was a "giveaway bin" where the public could obtain compost for home use. The compost placed in the giveaway bin was collected from a stockpile prior to screening and therefore still contained all of the wood chips used as a bulking agent during the composting process. The other sampling point was the final screened compost from which the larger wood chips had been removed. The screened compost was utilized through a bulk distribution program which included agricultural utilization, ballfield renovation, strip mine renovation and a marketing program. The majority of the compost was distributed through these options. The giveaway bin represented a fairly minor portion of the total compost distributed, but that material was specifically available to the general public for uncontrolled home use. Instructions for use were available at the giveaway bin.

The other facility was located on the West Coast and employed the windrow composting method. Essentially all of the compost produced at this facility was utilized by a private marketing company which used the compost as the base material for an entire line of commercial soil amendment products. The bagged products were marketed extensively through retail outlets for home garden use with instructions printed on the bag label.

Five sampling points were established at the West Coast facility. The first sample was collected from the final compost produced at the regional treatment plant prior to release to the commercial producer. Depending on the time of the year, one of two composting options was predominantly utilized. Wet sludge cake was mixed with sawdust as a bulking agent during the cooler periods of the year; previously dried compost was back-blended as the bulking agent during the warmer months. Although the finished compost only represented one sampling point, the data were separated based on the bulking agent used. The remaining sampling points were assigned to four commercially produced soil amendment products. Most of the time, bags of the commercial products were selected randomly from the producer's storage area. In a few cases, bags were purchased at retail outlets. The four products selected for sampling varied in final composition and accounted for the majority of the compost distributed.

Weekly sampling at the above sites was designed to provide a statistically valid data base to assess microbial population variability and to evaluate the potential for bacterial regrowth during the production of commercial soil amendment products derived from composted sludges.

Bimonthly Sampling

The second major task for the sampling program incorporated an expanded survey of twenty-four other municipal or regional facilities; the final sludge products were sampled bimonthly for a period of one year for microbiological testing. The participating sites represented many different sludge treatment processes including anaerobic digestion followed by dewatering and static pile composting, windrow composting or in-vessel composting. Facilities employing drying beds, preceded by either anaerobic or aerobic digestion, were also well represented, as well as two sites incorporating heat treatment processes. The participating facilities were well distributed around the continental United States.

Data from the bimonthly sites were intended to provide a broader representation of the quality of PSRP or PFRP treated sludges potentially utilizable in distribution programs. The results were evaluated individually and also grouped to compare productsproduced by various treatment options. The representativeness of these data was considered in context of the variability determined from the more concentrated weekly sampling.

Sampling for Chemical Analyses

The third task which was merged into this study was a survey of Priority Pollutant trace metals and organic compounds in D & M municipal sludges. In addition to the fate and occurrence of pathogens in treated sludges, there are also potential health implications associated with the possible presence of toxic chemicals in sludges destined for home use. Details of the sampling program and results of the chemical analyses are reported in a separate volume entitled Trace Organics and Inorganics in Distribution and Marketing Municipal Sludges.

SITE DESCRIPTIONS

The municipalities participating in this study and the associated sampling sites were identified by a semi-descriptive code. The three part code designation begins with a Roman numeral that corresponds to the EPA region in which the facility is located. The distribution of facilities by region is shown in Table 1.

Table 1. Regional Distribution of Study Sites[a]

Region	# Sites	Region	# Sites
I	1	VI	1
II	1	VII	2
III	4	VIII	4
IV	4	IX	6
V	2	X	1

a By USEPA Region Designations

The second part of the code is a letter that represents the basic sludge treatment process utilized by the treatment facility. The letter (process) codes and the distribution of sites by process is shown in Table 2.

Table 2. Process Codes and Site Distribution

Code Letter	Treatment Process	# Sites
A	Windrow Composting	3
B	Aerated Static Pile Composting	7
C	In-Vessel Composting	2
D	Anaerobic Digestion - Air Drying	7
F	Aerobic Digestion - Air Drying	2
H	Proprietary Composting Process	1
I	Heat Drying	1
J	Aerated Windrow Composting	2
K	Thermal Conditioning/Filter Press	1
	Total	26

The last number in the identification code designates a specific sampling point or identifies specific facilities in the same region. The following summary describes each sampling site. The weekly and bimonthly sampling sites are also listed in Table 3 and 4 respectively at the end of each set of descriptions.

Weekly Sampling Sites

III-B-1 and III-B-2 --

These two sampling points were located at a large mid-Atlantic region composting facility. The city treated a total of 550 mgd of wastewater at three treatment plants. The wastewater was estimated to come from 7% industrial and 93% domestic sources. Both primary and secondary sludges were produced which were anaerobically digested and dewatered by a combination of centrifugation and filtration. The final sludge treatment process employed was aerated static pile composting and resulted in an annual compost production of 213,000 dry tons. The sludge was composted for 21 days with wood chips added as a bulking agent. The compost was cured for 30 days prior to distribution. Wood chips were removed by screening and recycled. The final sludge product was distributed in bulk. The product was used by farmers (66%), homeowners (5%), nurseries (6%), landscapers (15%), and other users (8%) including ballfields, golf courses, strip mine reclamation, race tracks, and special projects.

III-B-1--This sampling point was the "giveaway bin". Material placed in the giveaway bin was removed from a curing pile while still containing the wood chips. Age of the compost in the giveaway bin varied relative to the seasonal demand. The material in the bin was available to the public for uncontrolled home garden use.

III-B-2--This sampling point was the final screened compost. The screened compost was stockpiled while awaiting bulk distribution. This material represented the majority of compost distributed through the various utilization programs.

IX-A-1 through IX-A-6--

These sampling points were located at a large West Coast composting facility. The treatment plant treated 360 mgd of wastewater which was estimated to come from 20% industrial and 80% domestic sources. Primary and secondary sludges were anaerobically digested and dewatered by centrifugation. The final sludge treatment process was windrow composting and resulted in an annual estimated compost production of 300,000 cubic yards. Composting time varied from 40 to 90 days depending on weather. Sawdust or previously composted sludge was used as a bulking agent. The compost was used by a private fertilizer company to produce a line of commercially retailed soil amendment products. The bagged products were sold predominantly to homeowners. The following descriptions nominally characterize the material sampled at each point. Undocumented deviations from these descriptions were known to occur.

IX-A-1-- This sampling point was final compost produced at the composting facility when sawdust was used as a bulking agent.

IX-A-2-- This sampling point was identical to IX-A-1 except that dried finished compost instead of sawdust was mixed with the wet sludge cake as a bulking agent.

IX-A-3--These samples represented a bagged commercially marketed product from the material described in IX-A-1, IX-A-2, and other sources. The compost was screened for uniformity prior to bagging. The product was marketed as an all purpose soil conditioner.

IX-A-4--This was a bagged commercially marketed product that contained an aged mixture of compost IX-A-1 or IX-A-2 and rice hulls. The mixture was screened for uniformity prior to bagging and was recommended as a vegetable and flower garden planting mix.

IX-A-5--This bagged commercially marketed product consisted of an aged mixture of compost and additional sawdust. The mixture was screened for uniformity and was marketed as a seed cover for new and reseeded lawns.

IX-A-6--This was a bagged commercially marketed product containing a blend of compost, sawdust, redwood chips, and fir bark. The blended material was aged and then screened before bagging. The product was recommended as a planting mix for acid loving plants.

Table 3. Weekly Sampling Sites[a]

LOCATION	Site Code	Sampling Point
1. Pensylvania Static Pile Composting Facility	III-B-1	Giveaway Bin
	III-B-1	Screened Compost
2. California Windrow Composting Facility	IX-A-1[b]	Final Sawdust Compost
	IX-A-2[b]	Final Recycle Compost
	IX-A-3[c]	Bagged Compost
	IX-A-4[c]	Bagged Compost with Rice Hull
	IX-A-5[c]	Bagged Compost with Sawdust
	IX-A-6[c]	Bagged Compost with Bark and Redwood

a. Sampled once every week from January 1986 - January 1987.

b. IX-A-1 and IX-A-2 were one sampling point.

c. Product compositions may have varied.

Bimonthly Sampling Sites

I-B-1--

Municipality I-B-1 treated 8.0 mgd of wastewater which was estimated to come from domestic (<50%), industrial (5%) and other (<50%) sources. Primary sludge was produced which was treated with lime prior to filtration dewatering. The final sludge treatment process employed was aerated static pile composting and resulted in an annual compost production of 4000 cubic yards per year. The sludge was composted for 21 days with woodchips added as a bulking agent. The compost was cured for 1 to 2 years prior to distribution. Wood chips were recycled. The final sludge product was distributed almost entirely in bulk by the operating agency. The product was used predominantly by homeowners.

II-C-1--

This county facility treated 7.0 mgd of wastewater which was estimated to come entirely from domestic sources. Primary and secondary sludges were produced which were not subjected to an additional stabilization process. Sludges were filtration dewatered. The final sludge treatment process employed was an in-vessel composting system and resulted in an annual compost production of 1,300 dry tons per year. The final sludge product was distributed 100% in bulk. The product was used entirely by landscapers.

III-B-3--

Municipality III-B-3 treated 309 mgd of wastewater. Primary and secondary sludges were produced which were treated with lime and filtration dewatered. The final sludge treatment process employed was aerated static pile composting and resulted in an annual compost production of 70,000 cubic yards. The sludge was composted for 21 days with wood chips added as a bulking agent. The compost was cured for 30 days prior to distribution. Wood chips were recycled. The final sludge product was distributed predominantly in bulk although a small portion was distributed in bags by a state agency. The product was used by homeowners (28%), nurseries (1%), landscapers (33%), and others (37%), including contractors, institutions, and top soil dealers.

III-B-4--

Treated wastewater was estimated to come from domestic (90%) and industrial (10%) sources. Secondary sludges were produced which were anaerobically digested and filtration dewatered. The final sludge treatment process employed was aerated static pile composting and resulted in an annual compost production of 9,200 cubic yards. The sludge was composted for 21 days with wood chips added as a bulking agent. The compost was cured for 30 days prior to distribution. Wood chips were recycled. The final sludge product was distributed entirely in bulk. The product was used by homeowners (49%), nurseries (2%), landscapers (35%), and others (14%).

III-J-1--

This facility treated 10 mgd of wastewater which was estimated to come from 95% domestic and 5% industrial sources. Primary, secondary, and chemical sludges were produced which were lime treated and anaerobically digested prior to filtration dewatering. The final sludge treatment process employed was an aerated windrow composting process and resulted in an annual compost production of 4,200 cubic yards. The sludge was composted for 21 days with recycled compost added as a bulking agent. The compost was cured for 30 days prior to distribution. The final sludge product was distributed 95% in bulk. The product was used by farmers (20%), homeowners (5%), landscapers (65%), and others (10%).

IV-B-1--

Treatment plant IV-B-1 treated 4.5 mgd of wastewater which was estimated to come from 35% domestic and 65% industrial sources. Secondary sludges were produced which were anaerobically digested and then dewatered by centrifugation. The final sludge treatment process employed was aerated static pile composting and resulted in an annual compost production of 6,500 cubic yards. The sludge was composted for 23 days with wood chips added as a bulking agent. The compost was cured for 23 days prior to distribution. Wood chips were recycled. The final sludge product was distributed almost entirely in bulk. The product was used by farmers (10%), homeowners (40%), nurseries (20%), and landscapers (30%).

IV-D-1--

This municipality treated 201 mgd of wastewater at a number of treatment plants which was estimated to come from 95% domestic and <5% industrial sources. Primary and secondary sludges were produced which were anaerobically digested and dewatered by centrifugation. The final sludge treatment process employed was drying beds and resulted in an annual sludge production of 20,000 dry tons. The final sludge product was distributed entirely in bulk by an outside company. The product was used by farmers.

IV-F-1--

Municipality IV-F-1 treated 2.6 mgd of wastewater which was estimated to come entirely from domestic sources. Secondary sludges were produced which were aerobically digested. The final sludge treatment process employed was drying beds. The final sludge product was distributed in bulk by the operating agency. The product was used by homeowners (60%) and nurseries (40%).

IV-I-1--

This facility treated 13 mgd of wastewater which was estimated to come from 95% domestic and 5% industrial sources. Secondary sludges were produced which were dewatered by centrifugation. The final sludge treatment process employed was a heat drying process and resulted in an annual sludge production of 3,000 dry tons. The final sludge product was distributed entirely in bulk by the operating agency. The product was used by farmers.

V-B-1--

Treatment plant V-B-1 treated 1.5 mgd of wastewater which was estimated to come from 90% domestic and 10% industrial sources. Primary and secondary sludges were produced which were thickened and filtration dewatered. The final sludge treatment process employed included both windrow and aerated static pile composting and resulted in an annual compost production of 900 dry tons. The sludge was composted with wood chips, sawdust, recycled compost, corn shucks and leaves added as bulking agents. The material was composted, cured, and stored for a total of 120 days prior to distribution. Wood chips were recycled. The final sludge product was distributed entirely in bulk by the operating agency. The product was used by farmers (5%), homeowners (90%), nurseries (2.5%), and landscapers (2.5%).

V-K-1--

This municipality treated 6.4 mgd of wastewater which was estimated to come from 32% industrial, 25% domestic, and 43% other sources. Primary and secondary sludges were produced which were thermally conditioned with a commercial system and filtration dewatered. The sludge treatment process resulted in an annual sludge production of 3300 cubic yards. The final sludge product was not distributed; the product was disposed in a landfill. This facility was included to evaluate the effects of thermal pretreatment.

VI-D-1--

Municipality IV-D-1 treated 112 mgd of wastewater which was estimated to come from 10% industrial and 90% domestic sources. Primary and secondary sludges were produced which were anaerobically digested. The final sludge treatment process employed was drying beds and resulted in an annual sludge production of 30,000 dry tons. The dried sludge was stored prior to distribution. The final sludge product was distributed in bulk by the operating agency. The product was used by the Park and Highways Departments.

VII-D-I--

This municipality treated 38 mgd of wastewater which was estimated to come from 55% industrial and 45% domestic sources. Primary and secondary sludges were produced which were anaerobically digested and dewatered by a combination of filtration and lagooning. The final sludge treatment process employed was windrow drying and resulted in an annual sludge production of 5,000 dry tons. The first three samples received from this site were composites of sludge that had been windrow dried and stored for two or more years prior to distribution. Sludge processing was changed at the facility to include the addition of 20% cement kiln dust to the wet sludge. The remaining three samples contained the kiln dust and represented recently processed sludge. The final sludge product was distributed in bulk to other city agencies after a two year holding period.

VII-A-2--

Municipality VII-A-2 treated 16.5 mgd of wastewater which was estimated to come from 20% industrial and 80% domestic sources. Primary and secondary sludges were produced which were anaerobically digested and filtration dewatered. The final sludge treatment process employed was windrow composting and resulted in an annual compost production of 3100 dry tons. The sludge was composted for 42 days without any added bulking agents. The compost was cured for 1.5 years prior to distribution. The final sludge product was distributed entirely in bulk by the operating agency. The product was used by homeowners (10%), landscapers (45%) and governmental agencies (45%).

VIII-D-1--

This facility treated 2.0 mgd of wastewater which was estimated to come from 90% domestic and 10% other sources. Secondary sludges were anaerobically digested. The final sludge treatment process employed was drying beds. The final sludge product was distributed in bulk by the operating agency. The product was used by homeowners (85%) and landscapers (15%).

VII-F-1--

Treatment plant VIII-F-1 treated a variable flow of 4 to 10 mgd of wastewater which was estimated to come from 99% domestic and 1% industrial sources. Secondary sludges were produced which were aerobically digested. The final sludge treatment process employed was drying beds and resulted in an annual sludge production of 260 dry tons. The dried sludge was stored prior to distribution. The final sludge product was distributed in bulk by the operating agency. The product was used entirely by homeowners.

VIII-H-1--This municipality treated 7 mgd of wastewater which was estimated to come from 2% industrial and 90% domestic sources. Secondary sludges were produced which were anaerobically digested and filtration dewatered. The sludge was composted by a private company and used to produce a line of commercially marketed products. The sludge was composted for 180 days with wood chips, sawdust, and proprietary ingredients added as bulking agents. The final sludge product was distributed 50% in bulk and 50% in bags. The product was used by homeowners (70%), nurseries (10%), landscapers (15%), and others (5%).

VIII-J-1--

Municipality VIII-J-1 treated 150 mgd of wastewater which was estimated to come from 90% domestic and 10% industrial sources. Primary and secondary sludges were produced which were anaerobically digested and dewatered by centrifugation. The final sludge treatment process employed was aerated windrow composting and resulted in an annual compost production of 30,000 dry tons. The sludge was composted for 25 days with wood chips and other materials added as bulking agents. The final sludge product was distributed in bulk by the operating agency . The product was used by farmers, homeowners, nurseries, landscapers, and others.

IX-A-10--

This municipality treated 8.5 mgd of wastewater which was estimated to come from 8% industrial, 69% domestic, and 23% commercial and institutional sources. Primary and secondary sludges were produced which were anaerobically digested and dewatered by a combination of gravity thickening, drying beds, and centrifugation. Ths final sludge treatment process employed was windrow composting and resulted in an annual compost production of 20,000 cubic yards. The sludge was composted for 60 days with rice hulls added as a bulking agent. The compost was cured for 30 days prior to distribution. The final sludge product was distributed in bulk by an outside contractor. The product was used by homeowners (10%), nurseries (20%), and landscapers (70%).

IX-B-1--

This regional facility treated 80 mgd of wastewater which was estimated to come from 13% industrial, 65% domestic, and 22% commercial sources. Primary and secondary sludges were produced which were anaerobically digested and dewatered by centrifugation. The final sludge treatment process employed was aerated static pile composting and resulted in an annual compost production of 125,000 cubic yards. The sludge was composted for 25 days with wood chips added as a bulking agent. The compost was cured for 30 days prior to distribution. Wood chips were recycled. The final sludge product was distributed 95% in bulk and 5% in bags by an outside contractor. The product was used by homeowners (70%), nurseries (5%), and landscapers (25%).

IX-D-1--

Municipality IX-D-1 treated 165 mgd of wastewater which was estimated to come from 7% industrial and 93% domestic sources. Primary and secondary sludges were produced which were anaerobically digested. The final sludge treatment process employed was drying beds and resulted in an annual sludge production of 50,000 cubic yards. The final sludge product was stockpiled. Marketing was planned for the future.

IX-D-2--

Treatment plant IX-D-2 treated 150 mgd of wastewater which was estimated to come from 8% industrial and 92% domestic sources. Primary and secondary sludges were produced which were anaerobically digested and dried in lagoons. The final sludge treatment process employed was drying beds and resulted in an annual sludge production of 30,000 dry tons. The final sludge product was distributed entirely in bulk by an outside contractor. The product was used farmers.

IX-D-3--

This facility treated 155 mgd of wastewater which was estimated to come from 5% industrial and 95% domestic sources. Primary and secondary sludges were produced which were anaerobically digested and dried in lagoons. The final sludge treatment process employed was drying beds and resulted in an annual sludge production of 40,000 dry tons. The final sludge product was distributed in bulk by an outside contractor. The product was used by farmers (90%) and landscapers (10%).

Table 4. Bimonthly Sampling Sites*

Site Code		Location	Process	Classification
1.	I-B-1	Maine	Static Pile	PFRP
2.	II-C-1	New Jersey	In-Vessel	PFRP
3.	III-B-3	Maryland	Static Pile	PFRP
4.	III-B-4	Virginia	Static Pile	PFRP
5.	III-J-1	Virginia	Aerated Windrow	PFRP
6.	IV-B-1	North Carolina	Static Pile	PFRP
7.	IV-D-1	Florida	Drying Bed	PSRP
8.	IV-F-1	Florida	Aerobic Digestion-Air Dried	PSRP
9.	IV-I-1	Georgia	Heat Drying	PFRP
10.	V-B-1	Indiana	Static Pile	PFRP
11.	V-K-1	Indiana	Thermal/Filter Press	PFRP
12.	VI-D-1	Texas	Air Dried	PSRP
13.	VII-D-1	Kansas	Air Dried	PSRP
14.	VII-A-2	Kansas	Windrow	PFRP
15.	VIII-D-1	Colorado	Air Dried	PSRP
16.	VIII-F-1	Utah	Aerobic Digestion-Air Dried	PSRP
17.	VIII-H-1	Montana	Proprietary	PFRP
18.	VIII-J-1	Colorado	Aerated Windrow	PFRP
19.	IX-A-10	California	Windrow	PFRP
20.	IX-B-1	California	Static Pile	PFRP
21.	IX-D-1	California	Air Dried	PSRP
22.	IX-D-2	Arizona	Air Dried	PSRP
23.	IX-D-3	Arizona	Air Dried	PSRP
24.	X-C-1	Oregon	In-Vessel	PFRP

* Sampled once every two months from April 1986 - April 1987.

Note: Air dried sludges were anaerobically digested unless otherwise stated.

X-C-1--

Municipality X-C-1 treated 71 mgd of wastewater which was estimated to come from 40% industrial and 60% domestic sources. Primary and secondary sludges were produced which were anaerobically digested and filteration dewatered. The final sludge treatment process employed was an in-vessel composting system and resulted in a proposed annual compost production of 60,000 cubic yards. The sludge was composted for 15 days with sawdust added as a bulking agent. The compost was cured for 15 days prior to distribution. The final sludge product was distributed in bulk by an outside contractor. The product was used by homeowners (1%), nurseries (4%), landscapers (70%), and other users (25%).

SELECTION OF MICROORGANISMS FOR TESTING.

The microorganisms selected for quantitative analysis during this project can generally be divided into two broad groups, the indicator organisms, and the pathogens. In some cases, however, that separation is not distinct. For example, the coliform bacteria are commonly used as indicator bacteria but a subgroup of the coliforms, the enterotoxigenic *E. coli*, are pathogens. Nevertheless, the basic separation is useful and reflects the primary reason for determining the presence of the organisms. Table 5 lists the organisms included for analysis.

Table 5. Microorganisms Selected for Analysis

Indicator Groups	Pathogenic Microorganisms
Total coliform	Enterotoxigenic *E. coli*
Fecal coliform	Total enteric bacteria
Fecal streptococci	*Salmonella*
Aerobic plate count	*Campylobacter*
Anaerobic Plate count	*Yersinia*
Total Fungi	*Ascaris ova*
Thermophilic fungi	Total parasites
Bacteriophage	Total enteric viruses

The indicator groups, collectively, served two purposes in this study. The first was to determine if there was a correlation between standard or non-standard indicators and the occurrence of any pathogens detected. The use of indicator organisms, such as coliforms, fecal streptococci and plate count organisms has been a long established practice in sanitary microbiology, however, the significance of indicators in treated sludges was uncertain. The second purpose of the indicator groups was to ascertain if post treatment bacterial or fungal regrowth occurred to any significant extent.

The pathogens listed in Table 5 were selected on the basis of three criteria: (a) enteric pathogens previously demonstrated in sludges, (b) enteric pathogens of current epidemiological concern whose presence or fate in sludge was unknown and (c) pathogens of potential concern due to the nature of exposure associated with home use of sludge products.

Many of the tests for the microorganisms listed in Table 5 are standard tests. However, some of the procedures and associated terminology are non-standard and should be defined to avoid confusion. The following definitions apply. Laboratory methods are described in Section 5.

Total and Thermophilic Fungi - The term total fungi, as used here, is somewhat of a misnomer. Mesophilic and thermophilic fungi would be more accurate descriptive terms. No one medium or incubation temperature is adequate to recover all of the fungi potentially present. An evaluation of fungal media and incubation temperatures was conducted during the initial stage of the study to select the most productive media and temperatures. Results of this evaluation are detailed in Appendix A. In many cases, there is a great deal of overlap between the fungi in the two groups. At other times, the two populations may be mutually exclusive. It is posible to have a substantial number of thermophilic fungi and no total fungi, or vice-versa.

Bacteriophage - The bacterial virus measured in this study was the coliphage that infects *E. coli C*.

Enterotoxigenic E. coli - The initial proposal indicated that the potential health risk associated with enteropathogenic *E. coli* would be addressed by screening a representative portion of *E. coli* isolates with commercially prepared antisera for the most common pathogenic serotypes. A 1970 publication by the American Public Health Association listed 11 serogroups that were most frequently associated with *E. coli* diarrhea. More recent publications (Sack, 1975) however, indicated that there was little relationship between serotype and pathogenicity of a strain. Conversations with the Los Angeles County-University of Southern California Medical Center clinical laboratory and the Los Angeles County Public Health Department laboratory revealed that these laboratories no longer assigned any clinical or public health significance to the presence of the classic "pathogenic" serogroups.

The cholera-like symptoms produced by pathgogenic *E. coli* strains are usually the result of enterotoxins produced by the organisms. Two general types of enterotoxins are produced: heat-stable (ST) and heat-labile (LT). Almost all human strains studied have been shown to produce both types (Sack, 1975). The ability to produce enterotoxins is carried by plasmids. *E. coli* serotypes might contain, or conversely lose, the enterotoxin-controlling plasmid. It has been speculated that many serotypes originally described as enteropathogenic were enterotoxigenic.

Because of the discrepancy between enteropathogenic serotypes and enterotoxigenic properties, there is confusion in defining these terms. Sack (1975) recognized two basic types of diarrheagenic *E. coli*: (a) enterotoxigenic strains, and (b) invasive strains. More recently, a World Health Organization (WHO) working group (1980) defined three forms: (a) enterotoxigenic, (b) enteropathogenic, and (c) enteroinvasive. The enterotoxigenic and enteroinvasive groups are the same as described by Sack. The enteropathogenic group defined by WHO includes *E. coli* strains shown to produce enteritis but where no virulence factors have been identified. The enteroinvasive *E. coli* strains are biochemically and antigenically similar to *Shigella*. It is likely that many outbreaks due to these organisms have been reported as shigellosis (WHO 1980). From a purely clinical point of view, the difference is probably moot.

In order to assess potential health risk associated with diarrheagenic *E. coli*, this study tested *E. coli* populations for enterotoxigenic strains. The term enterotoxigenic will be used exclusively and will refer to those *E. coli* strains producing ST and LT enterotoxins.

Total Enteric Bacteria - This refers to a plate count performed on a common enteric isolation medium, MacConkey agar. The purpose of this procedure was to detect enteric bacteria that were not analyzed by a more specific test. The plate count data reported for this test includes all organisms capable of growing on MacConkey agar. These include many bacteria that are not members of the *Enterobacteriaceae*, and therefore are not classic enteric bacilli.

Total Parasites - This category includes the sum of all parasitic helminth ova and protozoan cysts detected in a sample.

SECTION 5

MATERIALS AND METHODS

SAMPLING PROCEDURES

Compost or sludge samples were collected packed and shipped by personnel at each participating municipality. Sampling kits were provided for each sample collected. The sampling kit included two sterile 5 inch x 14 inch Whirl-Pak bags for microbiological samples, a 1 quart glass jar with a teflon lined lid for chemistry samples, a sterile scoop, polyfoam refrigerant packs, sampling instructions, a sample collection form, and a Freeze Safe insulated mailing container. The sampling instructions and documentation form are illustrated in Figures 1, 2, and 3.

When the sample arrived in the laboratory, sample documentation and labelling were checked, then the Whirl-Pak bag microbiology samples were stored at 4 C and the 1 qt. glass jar chemistry sample was stored in a -20 C freezer. Microbiological analyses were usually started within 5 days of sample collection.

MICROBIOLOGICAL METHODS

The microbiological methods which were used for this study are presented in outline form. All references to Standard Methods refer to the sixteenth edition (APHA, 1985). All media were prepared, and reactions interpreted, according to manufacturers' instructions, unless otherwise stated.

Sample Preparation

Dewatered sludge samples or compost samples were suspended in an appropriate diluent in order to inoculate broths and/or plates for microbiological analyses.

A. Preparing suspension (two blender jars were prepared, one for bacterial tests and one for parasite tests)

1. 50 g of sample was weighed into a sterile 1 qt. stainless steel Waring blender jar.
2. 500 mL sterile phosphate buffered dilution water (Standard Methods APHA, 1985) containing 0.1% Tween 80 (acts as dispersant) was added.

Figure 1. Form Letter Detailing Sludge Sampling Procedures

Procedures for POTW Sludge Sampling

The sampling of sludge at your wastewater treatment facility should be performed at the location specified previously.

Irrespective of where the sludge samples are actually collected, it is important that three basic objectives be kept in mind: (1) Samples should be representative of the bulk material from which they are collected, (2) Sludge character or quality should not be altered as a result of the sampling, and (3) Proper QA procedures appropriate for collecting samples for microbiological analyses should be adhered to. It is important that all procedures employed relative to sample collection are properly documented in a study plan or field log. (See sample collection form and instructions.)

Factors such as accessibility and physical characteristics of the sludge should be considered when selecting a sampling device and/or procedure. The sampling device should be clean and constructed of an inert or unreactive substance such as stainless steel or teflon. The sampling method will vary depending on the type of sample requested. Dried sludge in either a "cake" form or within a drying bed should be easily accessible and can be sampled using either a trowel, scoop, shovel or auger. Availability and ease of use will probably be the determining factor. A shovel or auger are better suited for sampling from a deeper bed of material, or a stock pile. Again, it should be emphasized that whatever sampler is used, proper cleaning procedures should be followed.

For purposes of this sampling program, it will be necessary to fill a 5 inch X 14 inch sterile Whirl-Pak bag and a 1 quart glass jar having a teflon lined lid. The bag should be filled about 2/3 full, and the jar should be filled as completely as possible. A sterile scoop is provided to fill the sample containers. Preservatives must not be added to any of the samples. Samples should be refrigerated and shipped as soon as possible.

Lastly, it is important that all samples are properly labeled and packaged prior to shipment. Using a felt marking pen, label the bag and jar with the site code, date, and time sample was collected. The samples should be packaged with a Freeze-Pak and every attempt should be made to ensure that the sample bottle will not be broken during transit. The insulated box containing the samples should also be taped, labeled, and shipped via Federal Express.

Any questions regarding sampling should be directed to Bill Yanko at the Los Angeles County Sanitation Districts (213) 685-9572.

Figure 2. Instructions Sent to Participating Facilities

INSTRUCTIONS FOR COMPLETING SAMPLE COLLECTION FORM
(Use a separate form for each sample)

I. Sample Information

1. Sample I.D.: The identifying information written on the label on the sample container. This information includes site code, sample number if more than one sample collected on same day, date, and time sample collected. Your site code is: __________.

2. Sampling Site: The name of treatment plant and/or city and state.

3. Field Sampling Manager: The name of person collecting sample.

4 and 5. Already completed.

6. Source Sampled: The point the sample was collected from, such as, "stockpile at treatment plant" or "bag of Grow Fast garden food" or "drying bed", etc.

7. Quantity Sampled: i.e., "2/3 of whirl pak bag" and/or "1 qt. jar".

8. Sample Description: i.e., "air dried digested sludge" or "windrow composted sludge" or "in-vessel composted sludge". Also indicate if composite sample or single grab sample.

9. Other Information: Air temperature: Self explanatory,

Weather: Brief description of prevailing weather conditions when samples collected, i.e., "cold, snow" or "intermittent rain" or "hot humid" etc. Pile Temperature: if sludge is in a stockpile and is self heating, or if sludge is above ambient temperature for any reason, measure sample temperature at a representative point or depth. Other is any other information you think may be pertinent regarding samples, such as, "flocks of seagulls feeding on tops of stockpiles", or "extremely heavy rains three days ago". Any information about conditions that could affect the sample would be helpful.

II. Handling and Shipping

1. Describe Sample Treatment Prior to Shipping: Briefly describe how you collected the sample. For example, "Using a clean shovel, removed approximately one foot of material from surface of stockpile. With clean scoop, collected sample and placed in sample containers".

2 and 3. Self explanatory

4. Comments: Any comments or observations concerning sampling that might influence laboratory results.

5. UPS, Federal Express, Etc.

6. Already Completed.

III. Arrival

This section is filled out by Laboratory.

Figure 3. Sample Collection Form Sent to Participants

SAMPLE COLLECTION FORM

I. Sample Information

1. Sample I.D. (Code)__________ Collection Date__________Time__________

2. Sampling Site______________________________

3. Field Sampling Manager (on site)______________________________

4. Contractor L.A. County Sanitation Dist. Contract No. CR-812589-010
5. EPA Project Officer W. Jakubowski Program Name Occurrence of Pathogens in Distribution and Marketing Municipal Sludges

6. Source Sampled ______________________________

7. Quantity Sampled/Units ______________________________

8. Sample Description ______________________________

____

9. Other Information as Applicable Air Temp _______ Pile Temp _______

Weather______________________ Other ______________________________

____

II. Handling and Shipping

1. Describe Sample Treatment Prior to Shipping ______________________________

____

____

____

2. Field Storage and Shipping Conditions

Container	Temperature
_________Whirl Pak Bag	_________Ambient
_________Glass With Teflon Lid Liner	_________Packed with Freeze Pak

3. Date and Time Shipped ______________________________

4. Comments______________________________

____

____

5. Mode and Carrier for Shipping ______________________________
6. Sample Shipped to: San Jose Creek Water Quality Laboratory
1965 So. Workman Mill Rd., Whittier, CA 90601
Attention: W. A. Yanko

III. Arrival (Lab use only) Date _______ Time _________ By__________
Lab Job No.__________ Charge No.__________________ Proj. No __________
Requested by: ______________________ Report To:__________________
Date and Time - Grab Sample:__________/__________/__________:__________
Sample Location______________________Type______________________

Description______________________________

3. The mixture was blended at medium to high speed for 1 minute.

B. Total Solids (TS) were determined for the original sample according to procedures described in Standard Methods (APHA, 1985). TS results were used to calculate final results from microbiological analyses, i.e., number of microorganisms/g dry weight sample.

Tests for Standard Indicator Organisms

A. Total coliform, fecal coliform, fecal streptococci.

1. Tubes of appropriate media for most probable number (MPN) tests were inoculated from the sample suspension.
2. Dilutions to be inoculated were selected based on experience of the anticipated range of bacteria in the samples.
3. Tests were performed and MPNs computed as described in Standard Methods (APHA, 1985).
4. Using TS data, final results were calculated and expressed as MPN/g dry weight.

B. Aerobic and anaerobic plate count.

1. 0.1 mL of dilutions from the sample suspension were inoculated onto duplicate plates of pre-dried plate count agar for each dilution.
2. Dilutions to be inoculated were selected based on experience of the anticipated range of bacteria in the samples.
3. Spread plate method tests were performed as described in Standard Methods (APHA, 1985).
4. Anaerobic plates were incubated in "Gas Pak" anaerobic jars, per manufacturer's instructions.
5. Plates were incubated at 35 C for 48 hrs.
6. Colonies were counted per Standard Methods (APHA, 1985) guidelines.
7. TS results were used to calculate and report final results as colony forming units (CFU)/g.

Tests for Non-Standard Indicator Organisms

A. Total Fungi

0.5 mL and 0.05 mL of sample suspension were inoculated onto predried plates of modified Rose Bengal agar and V-8 juice agar in triplicate for each dilution. Additional dilutions were necessary for some samples.

a. Modified Rose Bengal agar

Cooke Rose Bengal Agar (Difco)	36.0 g/L
Tergitol NP-10 (Baker)	0.1 mL/L
To autoclaved, cooled medium, add chloramphenicol (dissolve 0.1 g chloramphenicol in 4 mL ethanol).	0.1 g/L

b. V-8 juice agar

V-8 Juice cocktail	200 mL
Calcium carbonate	3.0 g
Yeast extract	2.0 g
Agar	20.0 g
Deionized (DI) water	720 mL
Tergitol NP10 (Baker)	0.1 mL

To autoclaved cooled medium, add 20 mL/L Pen-Strep stock (1 million units Penicillin G and 1.0 g Stretomycin sulfate per 100 mL); and 150 ppm Benlate (Dupont) (0.16 g Benlate 60% wettable powder in 10 mL sterile D.I. water); rinse into medium with 40 mL sterile D.I. water.

2. Fungal plates were incubated at 35 C for 48 hrs. while exposed to light.

3. Differential colony counts were done for each medium based on colony morphology.

4. Fungal colonies exhibiting adequate morphological characteristics were identified.

5. Fungal colonies not showing adequate reproductive characteristics were transferred to Potato Dextrose agar (Difco) and cultured for identification.

6. Fungal colonies were identified using standard keys (Barnett *et al* 1972, Raper *et al* 1965).

7. Differential counts were added together for total fungus counts.

8. Final results were calculated and expressed as CFU/g dry weight.

B. Thermophilic Fungi

1. Plates of Rose Bengal agar and V-8 juice agar were inoculated as described under Total Fungi.
2. Plates were incubated at 44 C for 48 hrs.
3. Colonies were counted and identified as described under Total Fungi.
4. Final results were calculated and expressed as CFU/g dry weight.

C. Bacteriophage

1. 40 g of sample was weighed into 400 mL of sterile 3% beef extract, pH 9.5 containing 0.4 mL/L antifoam B (Baker).
2. The mixture was blended in a sterile stainless steel Waring blender jar for 3 min. at high speed.
3. A portion of blended sample was poured into a 250 mL centrifuge bottle and centrifuged at 10,000 RPM (700 X g)for 15 minutes in a refrigerated centrifuge.
4. A portion of supernatant was collected and filtered through a 0.2 um porosity Millex (Millipore Corp.) filter pretreated with sterile 3% beef extract.
5. Samples were assayed by the soft agar overlay plaque assay technique (Adams 1959).
    a. Prepared plates of Trypticase soy agar (TSA) (BBL) were used as the base medium.
    b. 0.5 mL of sample (or dilution), 0.5 mL of a 12 hr. culture of _E. coli_ C (ATCC 13706, grown at 37 C on a shaker) and 1 mL of soft agar (Trypticase soy broth with 1% agar added) were mixed and poured over base medium. Duplicate plates were prepared of each dilution.
    c. Plates were incubated 18-24 hrs. at 37 C.
    d. Plaque forming units (PFU) were counted and calculated as PFU/g dry weight.

Tests for Pathogenic Bacteria

A. Enterotoxigenic _E. coli_

1. Positive EC tubes from the 10 mL inocula of the fecal coliform test were streaked onto M-Endo LES agar plates and incubated at 35 C for 18-24 hours.

2. Representative sheen producing colonies were picked and inoculated onto TSA slants (BBL). Cultures were incubated 18-24 hrs. at 35 C. Cultures were saved for enterotoxin assay.

3. One day before enterotoxin assay, cultures were transferred to trypticase soy broth and incubated 18-24 hrs. at 35 C.

4. Presumptive E. coli cultures were tested for enterotoxin production with the Y-1 adrenal cell culture test described by Sack (1975).

5. With each enterotoxin assay, "blind" positive and negative controls were included.

   a. Positive controls (provided by R. Sack)
      E. coli 408.3
      E. coli TC268C2
      E. coli K108C3

   b. Negative controls
      E. coli K(12)HFR
      E. coli B
      E. coli C

6. Sensitivity of Y-1 cells was tested by determining the greatest dilution of cholera toxin necessary to produce morphological changes in the Y-1 cell line.

B. Total Enteric Bacteria

1. 0.1 mL of sample dilutions from the sample suspension were inoculated onto duplicate plates of predried MacConkey CS agar (Difco), with agar increased to 1.5%. Quebec grid dishes (Lab-Tek 4018) were used.

2. Spread plate method tests were performed as described in Standard Methods (APHA, 1985).

3. Plates were incubated at 35 C for 48 hrs.

4. Colonies were counted per Standard Methods (APHA, 1985) guidelines and calculated and expressed as CFU/g dry weight.

5. Colonies were picked from the grid pattern on the dish for identification, according to the following guidelines:

   a. total count <50 . . . . .pick all grids
   b. total count >50, <100 . . .pick 1/2 grids
   c. total count >100, <300. . .pick 1/4 grids

6. Picks were streaked to TSA containing 1% dextrose and 0.08 g/L brom thymol blue, to assure pure cultures.

7. Cultures were identified, using Minitek Enterobacteriaceae or Nonfermenter test kits, according to manufacturer's instructions.

8. Which kit to inoculate was based on oxidase reaction and acid formation from dextrose on the modified TSA plate.

   a.

oxidase	acid from dextrose	test kit
+	+	Nonfermenter
+	-	Nonfermenter
-	+	Enterobacteriaceae
-	-	Nonfermenter

   b. One of the recommended controls was run with each set of samples. Control cultures were varied.

   c. Isolates were reported as percent of the total picks.

C. Salmonella

1. Tubes of SBG sulfa enrichment (Difco) were inoculated for MPN tests from the sample suspension (Walker and Yanko 1987). SBG sulfa enrichment broth was prepared fresh by heating in a water bath to 60-70 C for 30 min. instead of boiling for 10 min. as indicated in manufacturer's instructions.

2. SBG inoculated tubes were incubated 20-24 hrs. at 37 C.

3. Growth in SBG was streaked to plates of xylose-lysine desoxycholate (XLD) agar (Difco) and modified lysine iron agar (MLIA) (Difco base, modified as described by Rappold et al, 1979).

4. SBG enrichment broths were reincubated an additional 24 hrs.

5. Isolated colonies exhibiting typical salmonellae morphology were picked to slants of triple sugar iron agar (TSI) and lysine iron agar (LIA) (both Difco) and urease test broth (BBL).

6. Cultures showing the correct biochemical reactions were confirmed by agglutination with *Salmonella* polyvalent O antiserum (Difco).

7. When examining the primary isolation plates (XLD, MLIA) it was determined whether the pattern of presumptive salmonellae isolations followed a logical dilution distribution.

    a. If misses occurred, 1 mL from the corresponding 48 hr. SBG enrichment tube was inoculated into a fresh tube of SBG enrichment and incubated 24 hrs. at 37 C.

    b. These secondary enrichment tubes were streaked to isolate salmonellae as described above.

    c. MPNs were computed from enrichment tubes confirmed to contain salmonellae and reported as MPN/g dry weight.

D. *Campylobacter*

1. The sample suspension was swabbed and streaked on plates of Campy Agar (Gibco) (Blaser *et al* 1979, Ottolenghi *et al* 1987).

2. Plates were incubated at 42 C for 48 hrs. in a jar ported for gas flow. A microaerophilic atmosphere was maintained with a flow of gas (5% oxygen, 10% carbon dioxide 85% nitrogen). (Bergey's 1984). Gas was warmed and humidified by bubbling through a flask of DI water in the incubator.

3. Campy plates were examined for the presence of possible *Campylobacter* colonies.

4. Presumptive colonies were examined or tested for the following:

    a. microscopic morphology (*Standard Methods*, APHA 1985)
    b. cytochrome oxidase (Bergey's, 1984)
    c. catalase (Bergey's, 1985)

5. Isolates exhibiting correct reactions were confirmed by the following tests (Bergey's 1984):

    a. growth at 25 C (Brucella agar slant, Gibco)
    b. hippurate hydrolysis (Gibco)
    c. nalidixic acid sensitivity (30 microgram disk, Difco)
    d. indole production (SIM, Difco)
    e. hydrogen sulfide reaction (TSI)

E. Yersinia

1. Tubes of Peptone sorbitol bile salts (PSB) broth (Weagant *et al* 1983a) inoculated for MPN tests from the sample suspension

    a. PSB Enrichment Broth

Na_2HPO_4 anhydrous	8.23 g
NaH_2PO_4 H_2O	1.2 g
NaCl	5.0 g
D-Sorbitol	10.0 g
Bile Salts No. 3	1.5 g
Peptone	5.0 g
Deionized Water	1000 mL

Mix ingredients and dissolve. Dispense 10 mL portions into tubes and autoclave.

    b. Prepare double strength media for 10 mL inocula.

2. Enrichment tubes were incubated in a refrigerator for four weeks at 4-5 C.

3. After three weeks, turbid tubes were streaked to Yersinia selective agar (Difco) and incubated for 48 hr. at 24 C.

    a. Potential Yersinia colonies were picked to TSI Difco), LAIA (Difco Lysine Iron agar plus 10% L- Arginine) (Weagant 1936) and TSA (BBL)

TSI- acid/acid no gas, no hydrogen sulfide (some alkaline/acid)
LAIA - alkaline/acid, no gas, no hydrogen sulfide
TSA - colonies <1.0 mm (24 hr. 37 C).

    b. Colonies exhibiting correct presumptive reactions were confirmed by the following tests (Bergey's 1984):

Motility 25 C*	+
Motility 37 C*	-
Ornithine decarboxylase (Difco)	+
Urease (Urea agar base, Difco)	+
Simmons citrate (Difco)	-

* (Edwards & Ewing motility test medium)

4. Enrichment tubes were restreaked to *Yersinia* selective agar again after four weeks.

5. Enrichment tubes confirmed to contain *Yersinia* during earlier weeks were not retested.

6. MPNs were computed from confirmed *Yersinia* positive enrichment tubes and reported as MPN/g dry weight.

Tests For Parasites

A. Protozoan Cysts (adapted from Reimers *et al* 1981, see Appendix A)

1. A second blender jar of sample suspension was prepared as described in Sample Preparation.

2. 100 mL of homogenized sample was measured into a 100 mL centrifuge tube and centrifuged at 1250 RPM (400 x g) for 3 min.

3. Supernatant was poured off and the pellet resuspended in zinc sulfate (Sp. Gr. 1.20).

4. Tubes were centrifuged at 1250 (400 x g) RPM for 3 min.

5. Using a pasteur pipet, the surface of the zinc sulfate was carefully aspirated and transferred to a 15 mL conical centrifuge tube.

6. The tube was filled with deionized water and centrifuged at 1400 RPM (480 x g) for 3 min.

7. Supernatant was poured off and pellet resuspended in tube 1/2 full of acid-alcohol solution (0.1 N sulfric acid in 35% ethanol solution).

8. Approximately 3 mL of ether was added.

9. The tube was capped with a rubber stopper and inverted several times, venting each time.

10. The tube was centrifuged at 1800 RPM (660 x g) for 3 min.

11. The acid-alcohol, ether and plug was poured off and the tube inverted over a paper towel to prevent reagent from running back into tube.

12. After well drained, two drops of DI water were added to the pellet and mixed. Two smears were made on microscope slides.

    a. Slides were allowed to dry.
    b. They were fixed in Schaudinn's solution for a minimum of 1 hr.
    c. Slides were stained with trichrome stain.

13. Slides were examined microscopically with a high dry objective (45X) and 15X eyepiece.

B. Helminth Ova (adapted from Reimers et al 1981)

1. The remaining volume of homogenized sample (after removing 100mL for protozon test) was measured and poured through a 48 mesh seive placed in a large funnel over a two liter beaker.

2. Sample was washed through the sieve with several rinses of warm tap water catching the washings in the beaker.

3. The washed sample in the beaker was allowed to settle overnight.

4. The supernatant was siphoned off to just above the settled layer of solids in beaker.

5. The settled material in the beaker was mixed by swirling and poured into two 100 mL centrifuge tubes.

6. The beaker was rinsed two or three times and rinsings poured into two 100 mL centrifuge tubes.

7. The tubes were balanced and centrifuged at 1250 RPM (400 x g) for 3 min.

8. The supernatant was poured off and pellet resuspended thoroughly in zinc sulfate solution (Sp. Gr. 1.20).

9. Zinc sulfate was centrifuged at 1250 RPM for for 3 min.

10. The zinc sulfate supernatant was poured into a 500 mL Erlenmeyer flask, diluted with deionized water, covered and allowed to settle 3 hrs. or overnight.

11. The supernatant was aspirated off to just above the settled material.

12. The sediment was resuspended by swirling and pipetted into two to four 15 mL conical centrifuge tubes.

13. The flask was rinsed with deionized water two to three times and rinse water pipetted into tubes.

14. Tubes were centrifuged at 1400 (480 x g) RPM for 3 min.

15. Pellets were combined into one tube and centrifuged at 1400 RPM (480 x g) for 3 min.

16. Pellets were resuspended in acid alcohol solution and processed as described in Protozoan Cysts.

17. After completion of step A.11, the pellet was resuspended in 0.1% sulfuric acid and poured into Nalgene tubes with loose caps.

18. Tubes were incubated in a slant rack at 26 C for three to four weeks.

    a. Control ova dissected from an adult _Ascaris lumbricoides_ var. _suum_ were also incubated.

    b. When the majority of control ova had embryonated, samples were examined.

19. Concentrates were examined microscopically using a Sedgewick Rafter cell to enumerate detected ova.

    a. Viability was noted based on presence of embryonated ova and whether or not larval forms could be induced to move.

    b. Ova were identified and reported as ova/g dry weight.

Enteric Viruses

A. Processing Samples (Glass _et al_ 1978)

1. 40 g of sample was weighed into 400 mL of sterile 3% beef extract, neutral pH, containing 0.4 mL/L antifoam B.

2. The mixture was blended in a sterile stainless steel Waring blender jar for 3 min. at high speed.

3. The suspension was then disrupted by sonic treatment (Lab-Line model 9100 ultrasonic generator with 9106 horn at 170 W for 2 min.)

4. The suspension was centrifuged in 250 mL centrifuge bottles at 10,000 RPM (7,000 X g) for 15 min. in a refrigerated centrifuge.

5. The supernatant was recovered and pH adjusted to 3.5 with 6N HCl while mixing.

6. The pH 3.5 supernatant was mixed for 30 min.

7. The supernatant was centrifuged again as in step 4.

8. The supernatant was then discarded.

9. Pellets were dissolved and combined in 0.15 M Na_2HPO_4 (6 to 10mL) producing a concentrated eluate.

B. Detoxification of Sample (Glass et al 1978)

1. Dithizone in chloroform was prepared as described in Standard Methods (APHA, 1985).

2. An equal volume of dithizone solution was added to the concentrated eluant above.

3. The dithizone-eluant mixture was mixed for 2 min. on a vortex mixer.

4. The mixture was centrifuged 15 min. at 15,000 RPM (40,000 X g).

5. The upper aqueous phase was recovered and two drops of 1% calcium chloride was added.

6. Filtered air was gently bubbled through the sample for approximately 3 to 4 hrs. to remove residual chloroform.

C. Virus Assay

1. The final concentrate was subsampled for distribution to contract laboratories in addition to testing in the Districts' laboratory.

   a. 1.5 mL was sent to Pierre Payment, University of Quebec, for immunoperoxidase assay.

   b. 1.0 mL was saved for selective pooling for Charles Gerba, University of Arizona, Rotavirus assay.

c. The remainder of sample (4.5 to 7.5 mL) was used in the Districts' assay procedures.

2. 1.0 mL of sample was initially assayed for plaqueable virus on Buffalo green monkey kidney (BGM) monolayers.

    a. 0.2 mL of sample was added to each of five drained 2 oz. bottles containing BGM monolayers.

    b. A 2-3 hr. adsorption period was allowed at 37 C with frequent rocking.

    c. Sample was poured off and cells overlayed with Eagle Mminimum Essential Medium containing 1.2% purified agar (Difco) 5% fetal bovine serum, 25 mM magnesuim chloride, 100 units/mL pencillin, 0.75 ug/mL streptomycin, 0.017% neutral red, 1% milk and 0.2% sodium bicarbonate.

    d. Bottles were observed for up to 7 days for plaque formation.

3. If the plaque assay was negative, the remainder of sample was assayed by liquid overlay technique on BGM cells and rhabdomyosarcoma (RD) cells.

    a. Remaining sample was divided between two drained 16 oz. bottles containing BGM monolayers.

    b. A 2-3 hr. adsorption period was allowed at 37 C with frequent rocking.

    c. The sample was aspirated with a pipet and to one bottle, 40 mL Hank's Maintenance Medium with 5% lactalbumin hydrolysate, 0.5% tryptose, 0.455% HEPES buffer, 0.0525% sodium bicarbonate 100 ug/mL. streptomycin, 100 units pencillin and 0.75 ug/mL Fungizone was added.

    d. To the second bottle, 10 ug/mL trypsin was added to the serum free medium to enhance reovirus and rotavirus (M.D. Sobsey and P. Payment personal communication).

    e. The aspirated sample was reinoculated into two 16 oz. bottles of drained RD cells.

f. RD cells were treated as described in steps b. through d.

g. Bottles were observed at 24 hr. and every 48 hrs. for up to 14 days.

4. For blind passage, negative bottles from the preceding step were freeze/thaw lysed and the lysate retested as previously described.

5. Any bottles showing cytopathic effect (CPE) in step 3 or 4 were freeze/thaw lysed and passed to confirm virus CPE.

6. If the plaque assay in step 2 showed "polio-like" plaques within 48 hrs., the sample was reacted with polyvalent polio antisera before proceeding with steps 3 through 5.

D. Propagation of Cell Cultures

1. BGM and RD cells were grown in Eagle MEM (Alpha Modified) with 10% fetal bovine serum, 0.2% sodium bicardonate, 100 ug/mL streptomycin, 100 units/mL penicillin and 60 mcg/mL Tylosin.

2. BGM and RD cells were maintained in Hank's Maintenance Medium with 5% lactalbumin hydolysate 0.5% Tryptose, 0.455% HEPES buffer, 0.0525% sodium bicarbonate 100 ug/mL Streptomycin, 100 units/mL penicillin and 0.75 ug/mL Fungizone.

3. Cell cultures were trypsinized and subcultured weekly.

4. All cell cultures were grown and maintained at 37 C.

E. Contract Testing

Standard enteric virus analyses were performed in the project laboratory. In addition to the conventional tissue culture assays, two specialized virus assays were conducted by other research laboratories.

Composited sample concentrates were sent to Dr. Charles Gerba at the University of Arizona for rotavirus testing and aliquots of individual virus concentrates were sent to Dr. Pierrre Payment at the University of Quebec for virus testing by the immunoperoxidase-HISG method. Procedures for the rotavirus assay (Smith and Gerba 1982) and the immunoperoxidase assay (Payment and Trudel 1985) have been described elsewhere.

A number of Yersinia cultures derived from project samples were tested for pathogenicity by the New York State Department of Health. Yersinia characterization procedures have also been described elsewhere (Shayegani 1986).

Data Analyses

Statistical analyses were perfomed with BMDP Statistical Software on an IBM mainframe computer system. All statistical computations were performed with log (base 10) transformed data to more closely approximate a normal distribution. Data files were maintained in an in-house laboratory data management system that permitted direct transfer of files to the BMDP Program. Test results for indicator organisms were reported and tabulated in the log format to facilitate data handling. Log mantissas were carried to three places in order to maintain the correct two significant figures for the cardinal values of the microbiological data. T-distributions were analyzed using Bonferroni t statistics which apply to both balanced and unbalanced cases (Miller 1981).

Data for the fungal populations and total enteric bacterial populations were summarized in tables and bar graphs in Section 6 showing the relative diversity of populations. Fungal populations are often difficult to quantify and correspondingly troublesome to analyze. The fungal populations consisted of a few fungi that were detected regularly and numerous other fungi that occurred randomly. Two assumptions were made when analyzing these data: (1) If a given genus-species was detected once in a sample, it was considered part of a population. Those times it was not detected, it was assumed present, but below the detection limit. (2) If a given genus-species detected from any sample was not detected in samples from a particular sampling site, it was assumed that fungus was not part of the population at that site. The average concentration for each genus-species present was calculated. "Less than" values were assigned a value of one half the detection limit (Gleit 1985). Populations were then normalized to the least common fungus, ie each individual concentration was divided by the lowest value. In this way, the least common fungus is assigned a value of 1 and all other fungi obtain a positive ratio value greater than 1. This provides a relatively simple, albeit rough approximation, of the distribution of the populations.

In the case of the total enteric bacteria, the data were distributed based on the number of times a bacterial colony was identified as a particular genus-species, i.e., the results are presented as a frequency distribution.

The values plotted in the bar graphs represent the ratio of the number of isolations of any given bacteria to the least commonly isolated bacteria in the sample. Again, the intent was to provide a picture of how the populations distributed within a sample and varied between samples.

SECTION 6

RESULTS AND DISCUSSION

MICROBIOLOGICAL RESULTS - WEEKLY SITES

Indicator organisms

The data collected during this portion of the study indicated that microbial concentrations in compost were highly variable, sometimes ranging as much as ten orders of magnitude. Despite the variability and range of the data, normal probability plots showed that the log (base 10) transformed data followed a normal distribution. Basic descriptive statics for the indicator organisms are summarized in Tables 6 through 13 and the geometric means are grouped by faciltiy in Tables 14 and 15.

Comparative analysis of the two static pile facility sampling points, III-B-1 (giveaway bin) and III-B-2 (screened compost), indicated that all means were significantly different (significant at 95% CL) except the thermophilic fungi. The giveaway bin contained lower bacterial and coliphage concentrations and higher fungal levels than the screened compost. The lower bacterial levels could have been a result of the greater amount of wood in the giveaway bin compost. Since the test results were expressed on a per gram basis, data for the giveaway bin actually represented a smaller amount of sludge which may account for the difference. To test this theory, the amount of wood chips in giveaway bin compost samples vs screened compost samples was estimated. Representative samples from each site were thoroughly washed through a #14 USA standard sieve with openings of 1.4mm. After washing, the retained wood chips were collected from the screen and the dry weight determined. In this manner it was estimated that the screened compost contained 28% dry weight wood chips (>1.4mm) and the giveaway bin contained 78% dry weight wood chips (>1.4mm). Using these results the III-B-1 and III-B-2 data sets were recalculated to the adjusted bases and ANOVA and pairwise "t" tests were rerun. Results of this comparison are summarized in Table 16.

Normalizing the data for the difference in wood chips resulted in bringing the means of the bacterial groups closer together and increased the difference between the fungal populations. Fecal coliform, fecal streptococci and coliphage concentrations were still significantly lower and fungal populations were significantly

TABLE 6 INDICATOR ORGANISMS - SITE III-B-1, STATIC PILE COMPOST GIVEAWAY BIN

PARAMETER	LOG MPN/g			LOG CFU/g					LOG PFU/g
	TOTAL COLIFORM	FECAL COLIFORM	FECAL STREP	PLATE COUNT	ANAEROBIC PLATE COUNT	TOTAL ENTERIC	TOTAL FUNGI	THERM FUNGI	COLI-PHAGE
GEOMETRIC MEAN	6.018	5.084	5.259	9.031	7.811	7.942	5.034	5.010	2.033
STD. DEV.	1.627	1.888	1.771	0.819	0.976	1.045	1.155	1.192	1.461
S.E.M.	0.235	0.272	0.256	0.118	0.141	0.151	0.170	0.178	0.211
MAXIMUM	8.758	8.414	7.851	10.431	10.074	9.416	7.462	7.763	5.903
MINIMUM	2.431	1.396	1.255	7.041	6.301	5.591	2.000	2.301	0.699
NO. OF SAMP.	48	48	48	48	48	48	46	45	48

TABLE 7 INDICATOR ORGANISMS - SITE III-B-2, STATIC PILE COMPOST - SCREENED

PARAMETER	LOG MPN/g			LOG CFU/g					LOG PFU/g
	TOTAL COLIFORM	FECAL COLIFORM	FECAL STREP	PLATE COUNT	ANAEROBIC PLATE COUNT	TOTAL ENTERIC	TOTAL FUNGI	THERM FUNGI	COLI-PHAGE
GEOMETRIC MEAN	6.931	6.499	6.895	9.546	8.567	8.369	4.054	4.698	3.254
STD. DEV.	1.414	1.439	1.063	0.505	0.633	0.798	1.639	1.048	1.257
S.E.M.	0.211	0.215	0.158	0.075	0.094	0.119	0.250	0.160	0.187
MAXIMUM	9.380	8.903	8.875	10.230	9.619	9.388	5.857	6.826	5.217
MINIMUM	2.707	1.478	3.527	7.861	6.935	6.133	0.699	0.699	0.699
NO. OF SAMP.	45	45	45	45	45	45	43	43	45

TABLE 8 INDICATOR ORGANISMS - SITE IX-A-1, WINDROW COMPOST - SAWDUST

PARAMETER	LOG MPN/g			LOG CFU/g					LOG PFU/g
	TOTAL COLIFORM	FECAL COLIFORM	FECAL STREP	PLATE COUNT	ANAEROBIC PLATE COUNT	TOTAL ENTERIC	TOTAL FUNGI	THERM FUNGI	COLI-PHAGE
GEOMETRIC MEAN	2.851	2.210	2.503	8.347	6.694	7.068	2.077	2.206	1.403
STD. DEV.	2.677	2.516	1.603	1.193	1.614	1.764	1.666	1.392	0.669
S.E.M.	0.440	0.414	0.263	0.196	0.265	0.290	0.278	0.229	0.110
MAXIMUM	7.335	7.335	5.278	9.935	9.277	9.603	5.124	4.875	3.000
MINIMUM	-0.699	-0.699	-0.602	3.348	1.886	0.886	0.699	0.699	0.699
NO. OF SAMP.	37	37	37	37	37	37	36	37	37

TABLE 9 INDICATOR ORGANISMS - SITE IX-A-2, WINDROW COMPOST - RECYCLE

PARAMETER	LOG MPN/g			LOG CFU/g					LOG PFU/g
	TOTAL COLIFORM	FECAL COLIFORM	FECAL STREP	PLATE COUNT	ANAEROBIC PLATE COUNT	TOTAL ENTERIC	TOTAL FUNGI	THERM FUNGI	COLI-PHAGE
GEOMETRIC MEAN	2.031	1.198	3.408	8.018	6.133	7.028	1.378	1.146	0.981
STD. DEV.	2.200	1.897	1.287	0.739	1.621	1.103	1.331	0.949	0.071
S.E.M.	0.518	0.447	0.303	0.174	0.382	0.260	0.314	0.224	0.017
MAXIMUM	6.310	4.899	5.447	9.079	8.771	8.756	5.322	3.987	1.000
MINIMUM	-0.602	-0.602	0.301	6.633	3.813	4.462	0.699	0.699	0.699
NO. OF SAMP.	18	18	18	18	18	18	18	18	18

TABLE 10 INDICATOR ORGANISMS - SITE IX-A-3, BAGGED PRODUCT

PARAMETER	LOG MPN/g			LOG CFU/g					LOG PFU/g
	TOTAL COLIFORM	FECAL COLIFORM	FECAL STREP	PLATE COUNT	ANAEROBIC PLATE COUNT	TOTAL ENTERIC	TOTAL FUNGI	THERM FUNGI	COLI-PHAGE
GEOMETRIC MEAN	3.796	3.225	4.954	8.734	6.779	7.280	2.532	2.090	1.882
STD. DEV.	2.020	1.893	0.949	0.456	1.176	1.324	1.607	1.295	1.027
S.E.M.	0.280	0.262	0.132	0.063	0.163	0.184	0.223	0.180	0.142
MAXIMUM	7.613	6.235	7.190	10.102	8.909	9.351	6.000	6.114	4.176
MINIMUM	-0.699	-0.699	3.097	7.799	4.602	3.799	0.641	0.602	0.275
NO. OF SAMP.	52	52	52	52	52	52	52	52	52

TABLE 11 INDICATOR ORGANISMS - SITE IX-A-4, BAGGED PRODUCT/RICE HULL MIX

PARAMETER	LOG MPN/g			LOG CFU/g					LOG PFU/g
	TOTAL COLIFORM	FECAL COLIFORM	FECAL STREP	PLATE COUNT	ANEROBIC PLATE COUNT	TOTAL ENTERIC	TOTAL FUNGI	THERM FUNGI	COLI-PHAGE
GEOMETRIC MEAN	5.113	4.652	5.112	9.113	7.793	8.229	3.499	3.625	2.541
STD. DEV.	2.828	2.902	1.738	0.811	1.101	0.991	1.840	1.643	1.365
S.E.M.	0.396	0.406	0.243	0.114	0.154	0.139	0.268	0.237	0.191
MAXIMUM	8.611	8.192	7.879	10.176	9.432	9.479	6.556	6.467	5.097
MINIMUM	-0.699	-0.699	-0.222	6.672	5.756	4.826	0.653	0.699	0.699
NO. OF SAMP.	51	51	51	51	51	51	47	48	51

TABLE 12 INDICATOR ORGANISMS - SITE IX-A-5, BAGGED PRODUCT/SAWDUST MIX

PARAMETER	LOG MPN/g			LOG CFU/g					LOG PFU/g
	TOTAL COLIFORM	FECAL COLIFORM	FECAL STREP	PLATE COUNT	ANEROBIC PLATE COUNT	TOTAL ENTERIC	TOTAL FUNGI	THERM FUNGI	COLI-PHAGE
GEOMETRIC MEAN	6.033	5.636	5.838	9.003	7.706	8.456	3.299	2.932	2.955
STD. DEV.	2.257	2.376	1.544	0.643	1.039	0.686	1.346	1.287	1.526
S.E.M.	0.313	0.329	0.214	0.089	0.144	0.095	0.190	0.180	0.212
MAXIMUM	9.269	8.654	8.227	10.768	9.872	10.371	5.668	5.301	6.176
MINIMUM	-0.699	-0.699	1.025	7.279	5.505	6.691	0.699	0.699	0.699
NO. OF SAMP.	52	52	52	52	52	52	50	51	52

TABLE 13 INDICATOR ORGANISMS - SITE IX-A-6, BAGGED PRODUCT/MULTIPLE MIX

PARAMETER	LOG MPN/g			LOG CFU/g					LOG PFU/g
	TOTAL COLIFORM	FECAL COLIFORM	FECAL STREP	PLATE COUNT	ANEROBIC PLATE COUNT	TOTAL ENTERIC	TOTAL FUNGI	THERM FUNGI	COLI-PHAGE
GEOMETRIC MEAN	6.775	6.499	6.269	9.326	7.951	8.756	4.007	3.525	3.179
STD. DEV.	1.941	2.236	1.534	0.430	1.039	0.522	1.381	1.333	1.520
S.E.M.	0.272	0.313	0.215	0.060	0.145	0.073	0.201	0.187	0.213
MAXIMUM	9.884	9.884	8.895	10.085	9.564	9.717	6.681	5.580	5.964
MINIMUM	1.799	-0.699	2.556	8.355	5.924	7.821	0.699	0.699	0.699
NO. OF SAMP.	51	51	51	51	51	51	47	51	51

TABLE 14 INDICATOR ORGANISM SUMMARY, STATIC PILE FACILITY GEOMETRIC MEANS

SITE	LOG MPN/g			LOG CFU/g					LOG PFU/g
	TOTAL COLIFORM	FECAL COLIFORM	FECAL STREP	PLATE COUNT	ANEROBIC PLATE COUNT	TOTAL ENTERIC	TOTAL FUNGI	THERM FUNGI	COLI-PHAGE
III-B-1	6.018	5.084	5.259	9.031	7.811	7.942	5.034	5.010	2.033
III-B-2	6.931	6.499	6.895	9.546	8.567	8.369	4.054	4.698	3.254

TABLE 15 INDICATOR ORGANISM SUMMARY, WINDROW FACILITY GEOMETRIC MEANS

SITE	LOG MPN/g			LOG CFU/g					LOG PFU/g
	TOTAL COLIFORM	FECAL COLIFORM	FECAL STREP	PLATE COUNT	ANEROBIC PLATE COUNT	TOTAL ENTERIC	TOTAL FUNGI	THERM FUNGI	COLI-PHAGE
IX-A-1	2.851	2.210	2.503	8.347	6.694	7.068	2.077	2.206	1.403
IX-A-2	2.031	1.198	3.408	8.018	6.133	7.028	1.378	1.146	0.981
IX-A-3	3.796	3.225	4.954	8.734	6.779	7.280	2.532	2.090	1.882
IX-A-4	5.113	4.652	5.112	9.113	7.793	8.229	3.499	3.625	2.541
IX-A-5	6.033	5.636	5.838	9.003	7.706	8.456	3.299	2.932	2.955
IX-A-6	6.775	6.499	6.269	9.326	7.951	8.756	4.007	3.525	3.179

Table 16 Significance of Differences Between Means of Original and Adjusted Basis Data from Static Pile Sites III-B-1 and III-B-2.

TEST	ORIGINAL BASIS		ADJUSTED BASIS	
	MEAN DIFF	SIG	MEAN DIFF	SIG
Total Coliform Log MPN/g	-0.91	***	-0.40	
Fecal Coliform Log MPN/g	-1.37	***	-0.85	**
Fecal Strep Log MPN/g	-1.64	***	-1.12	***
Plate Count Log CFU/g	-0.52	***	0.00	
An. Plate Count Log CFU/g	-0.76	***	-0.24	
Total Enteric Log CFU/g	-0.43	**	0.09	
Total Fungi Log CFU/g	0.98	***	1.49	***
Therm. Fungi Log CFU/g	0.31		0.83	***
Coliphage Log PFU/g	-1.22	***	-0.71	**

Nomenclature

1% Significance	***
5% Significance	**
10% Significance	*
No Significance	

higher in the giveaway bin samples. The more generalized measures, total coliform and plate count populations, were no longer significantly different. It does appear that there is a difference in the microbial populations at these two sampling points, although in the case of the bacterial groups and coliphage, the differences are not as great as the original data indicates. The difference may reflect the presence of older material in the giveaway bin. The bin was filled with compost on a demand basis. During winter months, samples from the bin may have reflected older and dryer compost than the screened compost samples. The higher fungal populations in the giveaway bin material would also be consistent with the presence of older material. The data distribution can be visualized in the confidence intervals shown in Figure 4 where M is the mean and U and L are the upper and lower limits of the 95% confidence interval.

The data from the windrow facility sites IX-A-1 through IX-A-6 were analyzed by ANOVA; a significant difference was indicated (P<.99). Pairwise t tests were run (Bonferroni) and it was observed that the data had a tendency to group ito two strata. The first strtum included the completed compost, with either sawdust (IX-A-1) or recycled compost (IX-A-2) used as the bulking agent. The mean densities for all microbial groups were higher in sawdust compost than in recycle compost except the fecal streptococci which were higher in the recycle. None of these differences were statistically significant. The average concentration of organisms in the unamended bagged product, (IX-A-3) was higher than in the final compost material but lower than the amended bagged products. The unamended bagged product contained significantly higher levels of fecal coliform, fecal streptococci and plate count bacteria than in the recycle compost (IX-A-2) but only the fecal streptococci were significantly higher in the bagged product compared to the sawdust compost (IX-A-1). When compared to the bagged amended products (IX-A-4, IX-A-5 and IX-6), the unamended bagged material was significantly lower in 21 out of 27 comparisons. Although the concentrations of microorganisms in IX-A-3 generally tended to group more closely with the final field compost than with the other bagged products, the unamended bagged material appeared to represent an intermediate level between the two basic density groupings. The mean differences and significance levels are summarized in Table 17.

The second general grouping of data consisted of those bagged products in which the compost was blended with other materials, IX-A-4 through IX-A-6. The average concentration of organisms in the second stratum were significantly higher than those in the first. Within the second stratum, the mean concentrations of the individual bacterial groups increased in the following order: IX-A-4 < IX-A-5 < IX-A-6. Some of the individual differences were significant while others were not. Mean differences and significance levels for these sites are also shown in Table 17. The confidence intervals of the data are shown in Figure 5 where

FIGURE 4 T DISTRIBUTION OF SITE III-B-1 AND III-B-2 INDICATOR ORGANISMS
BEFORE AND AFTER ADJUSTING DATA FOR WOOD CHIP CONTENT

```
                           95% CONFIDENCE INTERVALS

                                -TOTAL COLIFORM-
                  SAMPLE        BEFORE ADJUSTMENT
   SITE      MEAN  SIZE
1 III-B-1    6.02   48    L___________M__________U
2 III-B-2    6.93   45                             L_________M_________U

             LOG MPN/g--+---------+---------+---------+---------+---------+
                       5.44      5.84      6.24      6.64      7.04      7.44

                  SAMPLE         AFTER ADJUSTMENT
   SITE      MEAN  SIZE
1 III-B-1    6.68   48      L_______________M_______________U
2 III-B-2    7.07   45                     L_____________M_____________U

             LOG MPN/g--+---------+---------+---------+---------+---------+
                       6.09      6.39      6.69      6.99      7.29      7.59


                                -FECAL COLIFORM-
                  SAMPLE        BEFORE ADJUSTMENT
   SITE      MEAN  SIZE
1 III-B-1    5.08   48    L__________M__________U
2 III-B-2    6.45   45                                 L________M________U

             LOG MPN/g--+---------+---------+---------+---------+---------+
                       4.45      4.95      5.45      5.95      6.45      6.95

                  SAMPLE         AFTER ADJUSTMENT
   SITE      MEAN  SIZE
1 III-B-1    5.74   48    L_____________M_____________U
2 III-B-2    6.59   45                            L__________M__________U

             LOG MPN/g--+---------+---------+---------+---------+---------+
                       5.12      5.52      5.92      6.32      6.72      7.12


                                  -FECAL STREP-
                  SAMPLE        BEFORE ADJUSTMENT
   SITE      MEAN  SIZE
1 III-B-1    5.26   48   L_________M_________U
2 III-B-2    6.89   45                                        L_____M_____U

             LOG MPN/g--+---------+---------+---------+---------+---------+
                       4.70      5.20      5.70      6.20      6.70      7.20

                  SAMPLE         AFTER ADJUSTMENT
   SITE      MEAN  SIZE
1 III-B-1    5.92   48   L____________M____________U
2 III-B-2    7.04   45                                    L_______M_______U

             LOG MPN/g--+---------+---------+---------+---------+---------+
                       5.36      5.76      6.16      6.56      6.96      7.36
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FIGURE 4 CONT'D.
                              -AEROBIC PLATE COUNT-
                  SAMPLE        BEFORE ADJUSTMENT
   SITE      MEAN  SIZE
1 III-B-1    9.03   48  L____________M____________U
2 III-B-2    9.55   45                                   L_______M_______U

             LOG CFU/g--+---------+---------+---------+---------+---------+
                       8.80      8.98      9.16      9.34      9.52      9.70

                  SAMPLE         AFTER ADJUSTMENT
   SITE      MEAN  SIZE
1 III-B-1    9.69   48   L_______________________M_______________________U
2 III-B-2    9.69   45            L______________M______________U

             LOG CFU/g--+---------+---------+---------+---------+---------+
                       9.44      9.54      9.64      9.74      9.84      9.94


                             -ANAEROBIC PLATE COUNT-
                  SAMPLE        BEFORE ADJUSTMENT
   SITE      MEAN  SIZE
1 III-B-1    7.81   48   L__________M__________U
2 III-B-2    8.57   45                                     L_______M_______U

             LOG CFU/g--+---------+---------+---------+---------+---------+
                       7.50      7.75      8.00      8.25      8.50      8.75

                  SAMPLE         AFTER ADJUSTMENT
   SITE      MEAN  SIZE
1 III-B-1    8.47   48    L__________________M__________________U
2 III-B-2    8.71   45                          L____________M____________U

             LOG CFU/g--+---------+---------+---------+---------+---------+
                       8.16      8.31      8.46      8.61      8.76      8.91


                           -TOTAL ENTERIC PLATE COUNT-
                  SAMPLE        BEFORE ADJUSTMENT
   SITE      MEAN  SIZE
1 III-B-1    7.94   48   L______________M______________U
2 III-B-2    8.37   45                           L___________M___________U

             LOG CFU/g--+---------+---------+---------+---------+---------+
                       7.62      7.82      8.02      8.22      8.42      8.62

                  SAMPLE         AFTER ADJUSTMENT
   SITE      MEAN  SIZE
1 III-B-1    8.60   48        L___________________M___________________U
2 III-B-2    8.51   45      L_______________M_______________U

             LOG CFU/g--+---------+---------+---------+---------+---------+
                       8.20      8.35      8.50      8.65      8.80      8.95
```

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FIGURE 4 CONT'D.
                                  -TOTAL FUNGI-
                  SAMPLE        BEFORE ADJUSTMENT
   SITE      MEAN  SIZE
1 III-B-1    5.03    46                                L________M________U
2 III-B-2    4.05    43    L___________M___________U

             LOG CFU/g--+---------+---------+---------+---------+---------+
                       3.44      3.84      4.24      4.64      5.04      5.44

                  SAMPLE         AFTER ADJUSTMENT
   SITE      MEAN  SIZE
1 III-B-1    5.69    46                                    L______M______U
2 III-B-2    4.20    43   L_________M_________U

             LOG CFU/g--+---------+---------+---------+---------+---------+
                       3.60      4.10      4.60      5.10      5.60      6.10


                               -THERMOPHILIC FUNGI-
                  SAMPLE        BEFORE ADJUSTMENT
   SITE      MEAN  SIZE
1 III-B-1    5.01    45                L________________M________________U
2 III-B-2    4.70    43  L_______________M_______________U

             LOG CFU/g--+---------+---------+---------+---------+---------+
                       4.36      4.56      4.76      4.96      5.16      5.36

                  SAMPLE          AFTER ADJUSTMENT
   SITE      MEAN  SIZE
1 III-B-1    5.67    45                           L___________M___________U
2 III-B-2    4.84    43 L_________M_________U

             LOG CFU/g--+---------+---------+---------+---------+---------+
                       4.53      4.83      5.13      5.43      5.73      6.03


                                   -COLIPHAGE-
                  SAMPLE        BEFORE ADJUSTMENT
   SITE      MEAN  SIZE
1 III-B-1    2.03    48 L__________M__________U
2 III-B-2    3.25    45                                 L________M________U

             LOG PFU/g--+---------+---------+---------+---------+---------+
                       1.60      2.00      2.40      2.80      3.20      3.60

                  SAMPLE         AFTER ADJUSTMENT
   SITE      MEAN  SIZE
1 III-B-1    2.69    48 L_____________M_____________U
2 III-B-2    3.40    45                          L___________M___________U

             LOG PFU/g--+---------+---------+---------+---------+---------+
                       2.28      2.58      2.88      3.18      3.48      3.78
```

TABLE 12 PAIRWISE SIGNIFICANCE OF MEAN DIFFERENCES OF INDICATOR ORGANISMS IN WINDROW SAMPLES: IX-A-1 THROUGH IX-A-6

SAMPLE PAIRS	LOG MPN/G						LOG CFU/G										LOG PFU/G	
	TOTAL COLIFORM		FECAL COLIFORM		FECAL STREP		PLATE COUNT		ANAEROBIC PLATE COUNT		TOTAL ENTERIC		TOTAL FUNGI		THERMOPHILIC FUNGI		COLI-PHAGE	
	MEAN DIFF	SIG	MEAN DIFF	SIG	MEAN DIFF	SIG	MEAN DIFF	SIG	MEAN DIFF	SIG	MEAN DIFF	SIG	MEAN DIFF	SIG	MEAN DIFF	SIG	MEAN DIFF	SIG
IX-A-1 IX-A-2	0.82		1.01		-0.90		0.33		0.56		0.04		0.70		1.06		0.42	
IX-A-1 IX-A-3	-0.94		-1.02		-2.45	***	--0.39		-0.08		-0.21		-0.45		0.12		-0.48	
IX-A-1 IX-A-4	-2.26	***	-2.44	***	-2.61	***	-0.77	***	-1.10	***	-1.16	***	-1.42	***	-1.42	***	-1.14	***
IX-A-1 IX-A-5	-3.18	***	-3.43	***	-3.34	***	-0.66	***	-1.01	***	-1.39	***	-1.22	***	-0.73		-1.55	***
IX-A-1 IX-A-6	-3.92	***	-4.29	***	-3.77	***	-0.98	***	-1.26	***	-1.69	***	-1.93	***	-1.32	***	-1.78	***
IX-A-2 IX-A-3	-1.77	*	-2.03	**	-1.55	***	-0.72	***	-0.65		-0.25		-1.15		-0.94		-0.90	
IX-A-2 IX-A-4	-3.08	***	-3.45	***	-1.70	***	-1.10	***	-1.66	***	-1.20	***	-2.12	***	-2.48	***	-1.56	***
IX-A-2 IX-A-5	-4.00	***	-4.44	***	-2.43	***	-0.99	***	-1.57	***	-1.43	***	-1.92	***	-1.79	***	-1.97	***
IX-A-2 IX-A-6	-4.74	***	-5.30	***	-2.86	***	-1.31	***	-1.82	***	-1.73	***	-2.63	***	-2.38	***	-2.20	***
IX-A-3 IX-A-4	-1.32	*	-1.43	**	-0.16		-0.38		-1.01	***	-0.95	***	-0.97	**	-1.54	***	-0.66	
IX-A-3 IX-A-5	-2.24	***	-2.41	***	-0.88	**	-0.27		-0.93	***	-1.18	***	-0.77		-0.84	**	-1.07	***
IX-A-3 IX-A-6	-2.98	***	-3.27	***	-1.32	***	-0.59	***	-1.17	***	-1.48	***	-1.47	***	-1.44	***	-1.30	***
IX-A-4 IX-A-5	-0.92		-0.98		-0.73		0.11		0.09		-0.23		0.20		0.69		-0.41	
IX-A-4 IX-A-6	-1.66	***	-1.85	***	-1.16	***	-0.21		-0.16		-0.53		-0.51		0.10		-0.64	
IX-A-5 IX-A-6	-0.74		-0.86		-0.43		-0.32		-0.24		-0.30		-0.71		-0.59		-0.22	

NOMENCLATURE	
1% Significance	***
5% Significance	**
10% Significance	*
NO Significance	

```
FIGURE 5  T DISTRIBUTION OF SITE IX-A-1 THROUGH IX-A-6 INDICATOR ORGANISMS

                           95% CONFIDENCE INTERVALS

                  SAMPLE        -TOTAL COLIFORM-
   SITE      MEAN  SIZE
1 IX-A-1     2.85   37             L_____M_____U
2 IX-A-2     2.03   18      L_______M_______U
3 IX-A-3     3.80   52                      L__M__U
4 IX-A-4     5.11   51                             L____M____U
5 IX-A-5     6.03   52                                    L___M___U
6 IX-A-6     6.77   51                                          L__M__U

             LOG MPN/g--+---------+---------+---------+---------+---------+
                       0.30      1.80      3.30      4.80      6.30      7.80

                  SAMPLE        -FECAL COLIFORM-
   SITE      MEAN  SIZE
1 IX-A-1     2.21   37           L_____M_____U
2 IX-A-2     1.20   18    L_____M_____U
3 IX-A-3     3.23   52                    L___M___U
4 IX-A-4     4.65   51                            L____M____U
5 IX-A-5     5.64   52                                   L____M____U
6 IX-A-6     6.50   51                                         L___M___U

             LOG MPN/g--+---------+---------+---------+---------+---------+
                       0.0       1.50      3.00      4.50      6.00      7.50

                  SAMPLE          -FECAL STREP-
   SITE      MEAN  SIZE
1 IX-A-1     2.50   37    L____M____U
2 IX-A-2     3.41   18            L_____M_____U
3 IX-A-3     4.95   52                               L__M__U
4 IX-A-4     5.11   51                              L____M____U
5 IX-A-5     5.84   52                                      L___M___U
6 IX-A-6     6.27   51                                          L____M____U

             LOG MPN/g--+---------+---------+---------+---------+---------+
                       1.80      2.80      3.80      4.80      5.80      6.80

                  SAMPLE     -AEROBIC PLATE COUNT-
   SITE      MEAN  SIZE
1 IX-A-1     8.35   37             L_________M_________U
2 IX-A-2     8.02   18     L________M________U
3 IX-A-3     8.73   52                             L__M__U
4 IX-A-4     9.11   51                                    L_____M_____U
5 IX-A-5     9.00   52                                   L___M___U
6 IX-A-6     9.33   51                                            L__M__U

             LOG CFU/g--+---------+---------+---------+---------+---------+
                       7.52      7.92      8.32      8.72      9.12      9.52
```

```
FIGURE 5 CONT'D.
                  SAMPLE     -ANAEROBIC PLATE COUNT-
   SITE      MEAN  SIZE
1 IX-A-1     6.69   37                 L________M________U
2 IX-A-2     6.13   18   L____________M____________U
3 IX-A-3     6.78   52                      L____M____U
4 IX-A-4     7.79   51                                       L____M____U
5 IX-A-5     7.71   52                                      L___M___U
6 IX-A-6     7.95   51                                          L____M____U

             LOG CFU/g--+---------+---------+---------+---------+---------+
                       5.28      5.88      6.48      7.08      7.68      8.28

                  SAMPLE   -TOTAL ENTERIC PLATE COUNT-
   SITE      MEAN  SIZE
1 IX-A-1     7.07   37   L__________M__________U
2 IX-A-2     7.03   18   L__________M__________U
3 IX-A-3     7.28   52           L_______M_______U
4 IX-A-4     8.23   51                                L_____M_____U
5 IX-A-5     8.46   52                                      L___M___U
6 IX-A-6     8.76   51                                             L__M__U

             LOG CFU/g--+---------+---------+---------+---------+---------+
                       6.45      6.95      7.45      7.95      8.45      8.95

                  SAMPLE          -TOTAL FUNGI-
   SITE      MEAN  SIZE
1 IX-A-1     2.08   36              L______M______U
2 IX-A-2     1.38   18    L_______M_______U
3 IX-A-3     2.53   52                     L_____M_____U
4 IX-A-4     3.50   47                                L______M______U
5 IX-A-5     3.30   50                               L____M____U
6 IX-A-6     4.01   47                                        L____M____U

             LOG CFU/g--+---------+---------+---------+---------+---------+
                       0.56      1.36      2.16      2.96      3.76      4.56

                  SAMPLE       -THERMOPHILIC FUNGI-
   SITE      MEAN  SIZE
1 IX-A-1     2.21   37                  L______M______U
2 IX-A-2     1.15   18   L_____M_____U
3 IX-A-3     2.09   52                  L____M____U
4 IX-A-4     3.63   48                                      L______M______U
5 IX-A-5     2.93   51                              L____M____U
6 IX-A-6     3.53   51                                      L____M____U

             LOG CFU/g--+---------+---------+---------+---------+---------+
                       0.63      1.33      2.03      2.73      3.43      4.13

                  SAMPLE           -COLIPHAGE-
   SITE      MEAN  SIZE
1 IX-A-1     1.40   37         L__M__U
2 IX-A-2     0.98   18    LMU
3 IX-A-3     1.88   52                L___M___U
4 IX-A-4     2.54   51                         L_____M_____U
5 IX-A-5     2.96   52                               L______M______U
6 IX-A-6     3.18   51                                   L______M______U

             LOG PFU/g--+---------+---------+---------+---------+---------+
                       0.78      1.38      1.98      2.58      3.18      3.78
```

the mean (M) and upper (U) and lower (L) limits of the 95% confidence intervals are graphed. The tendency of the data to divide into the groups is apparent in this Figure. The significance of the mean differences can be readily visualized. Overlapping significance intervals generally indicate the means are not different at the 95% confidence level. Intervals that do not overlap indicate the respective means are significantly different. (When viewing this figure, only consider the lines, not the letters "U" and "L" when considering overlap. Overlapping confidence intervals may give a general indication of significance but are not based on the same statistical procedure used to test for significance. In this case the overlapping confidence intervals correspond well with the significance tests summarized in Table 17.)

Figure 5 clearly indicates that the modified bagged compost products contain significantly (95% CL) higher concentrations of microorganisms than the final windrow compost. These data suggest that adding amendments to compost, such as rice hulls and forest products, may stimulate bacterial and fungal growth. Coliphage populations also increased significantly further indicating the presence of an actively metabolizing bacterial population.

The most commonly occurring fungus, by far, was *Aspergillus fumigatus*. *Phialophora* sp. and *Mucor* sp. were also commonly isolated. *Absidia* sp. occurred often at the static pile facility but not at the windrow site. None of the isolated fungi were of profound significance healthwise.

The occurrence of *Aspergillus fumigatus* has been cited as a possible concern (Milner *et al* 1977). This ubiquitous fungus is a common allergen and may be an opportunistic pulmonary pathogen. Densities of *A. fumigatus* are tabulated in Table 18. *A. fumigatus* concentrations varied from approximately 5 CFU/g to 5500 CFU/g. In general, the aspergilli concentrations measured in the various compost products were similar to those reported by Milner *et al* (1977) at Beltsville but more diverse fungal populations were observed during this study.

The windrow composts contained significantly lower concentrations of aspergilli than the static pile composts. This is probably due to the greater amount of wood chips used and the recycling of wood chips in the static pile system. The effect of wood materials can also be seen at the windrow facility. Site IX-A-2, windrow compost without any sawdust, contained 86% less *A. fumigatus* than IX-A-1 samples which were composted with sawdust. Aspergilli levels also increased in the commercially bagged products that contained increasing amounts of cellulosic materials.

Although *A. fumigatus* is a relatively common fungus, these data support the cautionary measures suggested by Milner *et al* (1977) concerning dust control at composting sites.

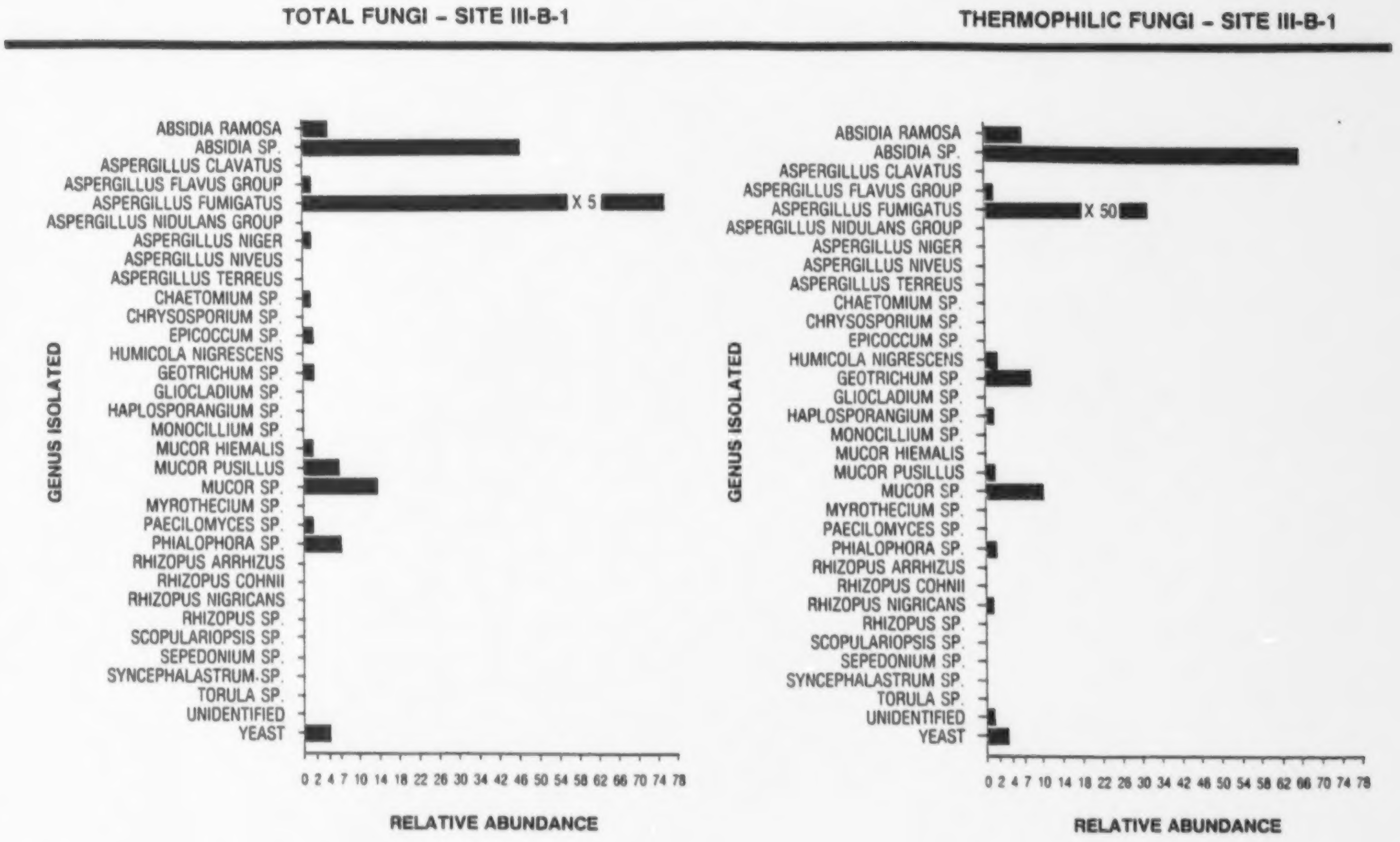
The relative abundance of the mean fungal populations for the one year sampling period is shown in Figures 6 through 13. This species distribution does not substantially distinguish between fungi that were detected infrequently and those that were detected regularly but at very low levels. It does allow one to see the relative distribution and diversity of the fungal populations and how the populations varied among the sampling sites. These relationships are relative, not quantitative, as described in the methods section.

The data are also shown numerically in Tables 19 and 20 along with the percentage of samples from which each species was isolated. The relative abundance number is a simple ratio of the occurrence of each species relative to the least isolated species at each site. A species with a relative abundance number of 40 was 40 times more abundant than a species with an abundance number of 1. Similarly, a species with an abundance number of 40 was twice as abundant as one with a value of 20.

Table 18 *Aspergillus fumigatus* Portion of Thermophilic and Total Fungi - Geometric Means

	LOG CFU/g		
Site	*Aspergillus fumigatus*	Thermophilic Fungi	Total Fungi
III-B-1	3.737	5.010	5.034
III-B-2	3.270	4.698	4.054
IX-A-1	1.538	2.206	2.077
IX-A-2	0.670	1.146	1.378
IX-A-3	1.735	2.090	2.532
IX-A-4	2.813	3.625	3.499
IX-A-5	2.720	2.932	3.299
IX-A-6	3.028	3.525	4.007

The weekly sampling for one year at the two large composting facilities was primarily intended to provide an adequate data base to assess microbial variabilty. It was also hoped that seasonal effects, if present, would be detected. No readily apparent seasonal trends were observed with the exception of *Yersinia*, which will be discussed in the section about pathogens.



TOTAL FUNGI - SITE III-B-1

THERMOPHILIC FUNGI - SITE III-B-1

Figure 6. Relative Abundance of Fungi, Site III-B-1

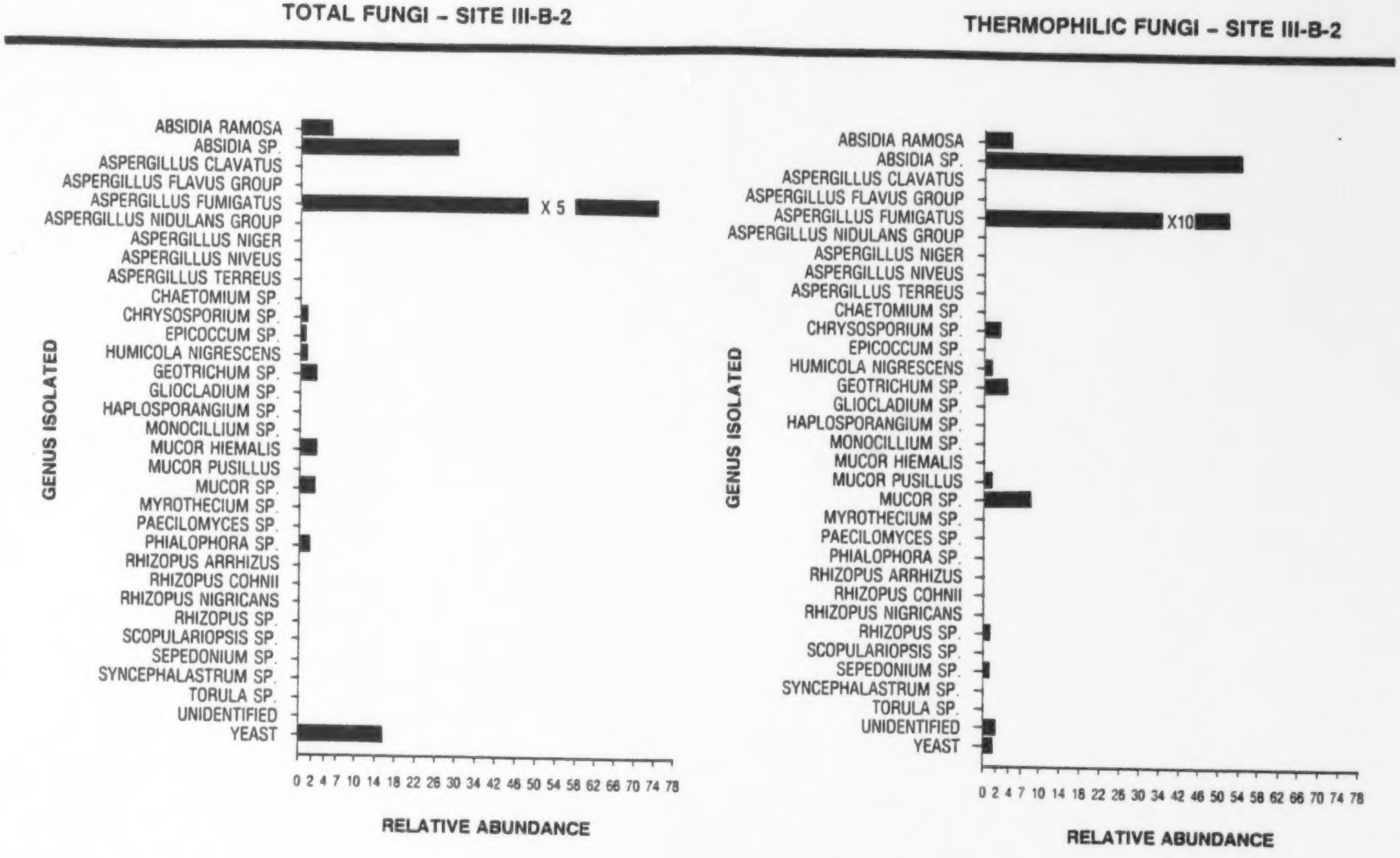
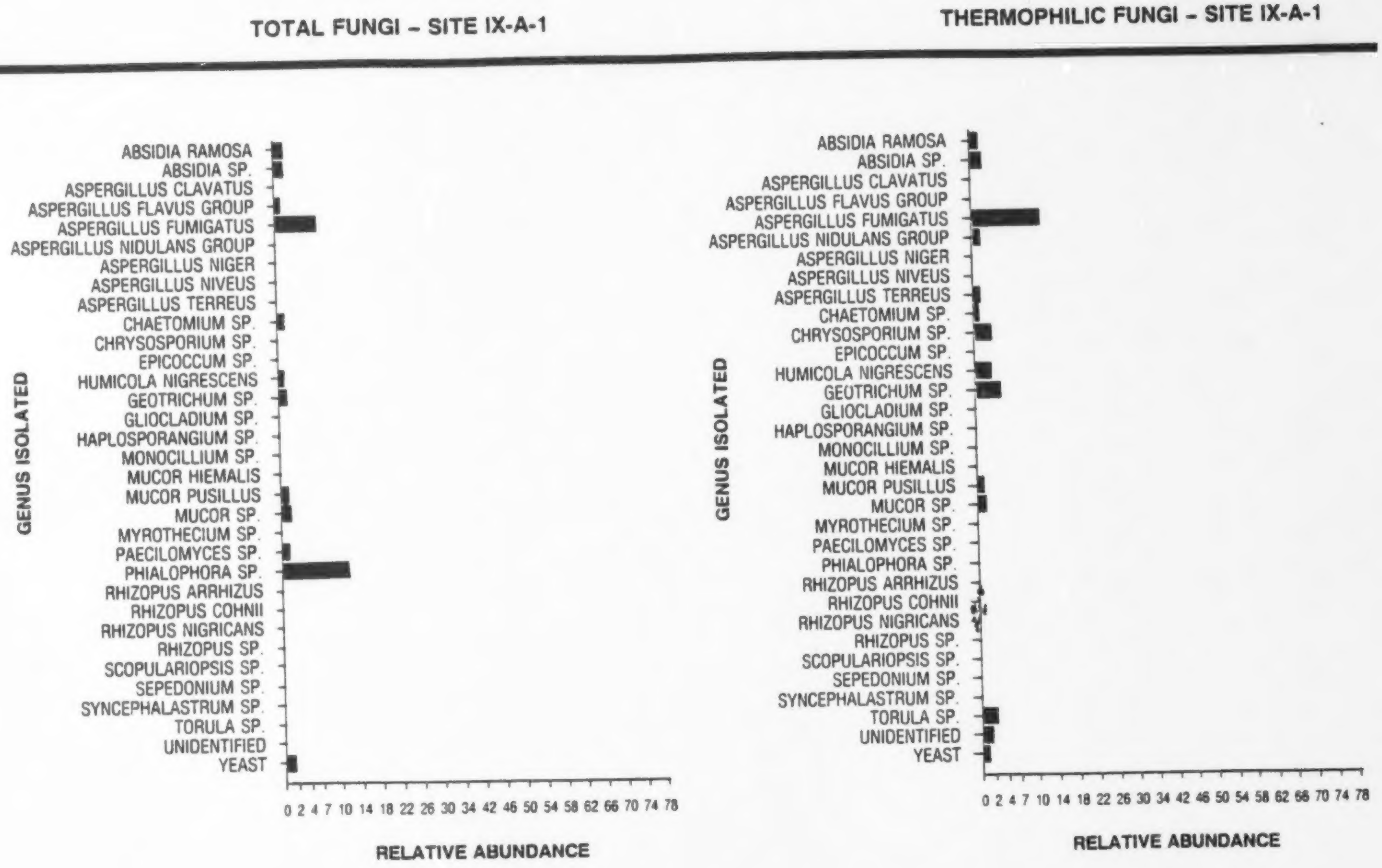


Figure 7. Relative Abundance of Fungi, Site III-B-2


TOTAL FUNGI – SITE IX-A-1

THERMOPHILIC FUNGI – SITE IX-A-1

Figure 8. Relative Abundance of Fungi, Site IX-A-1

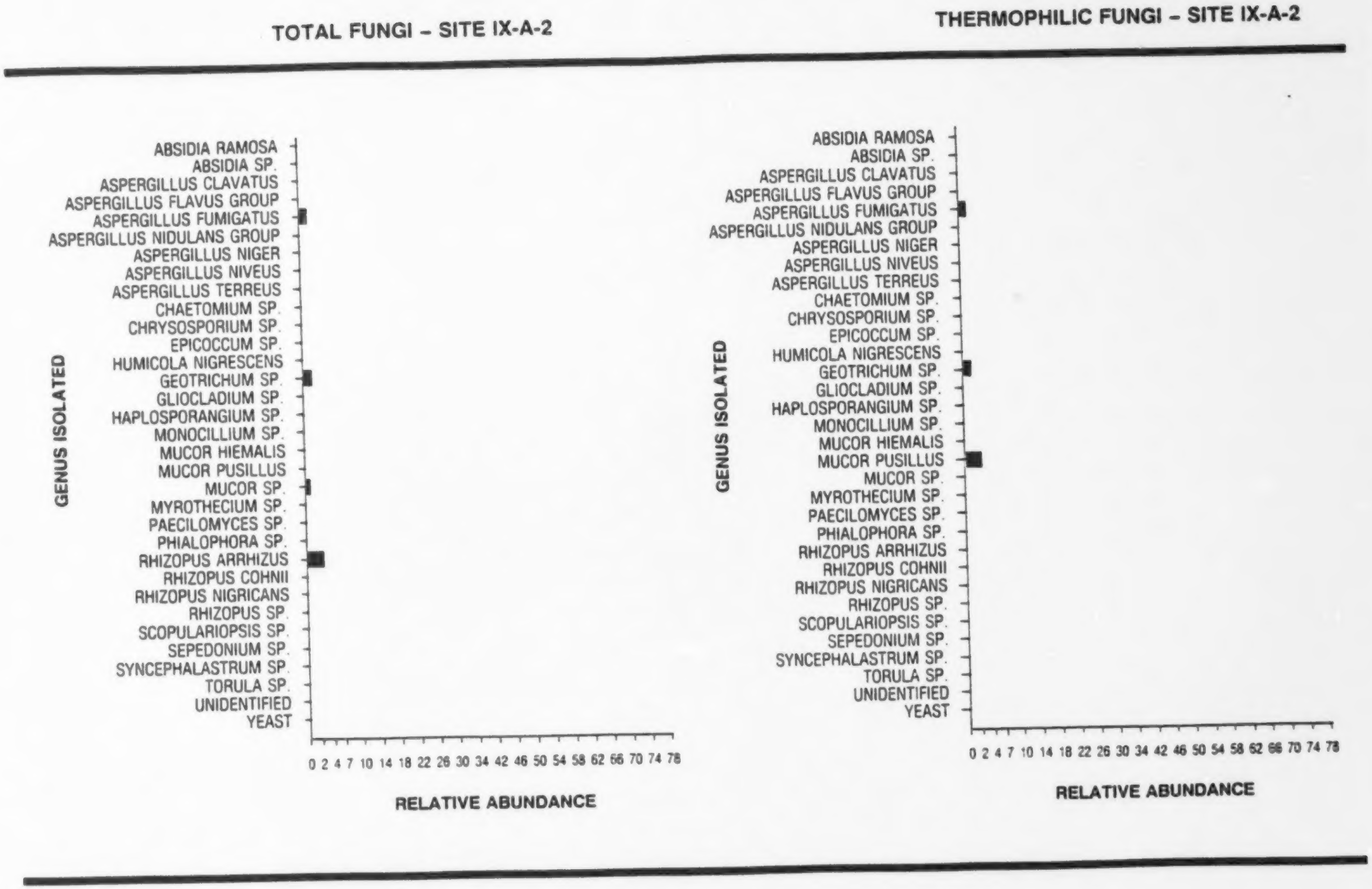
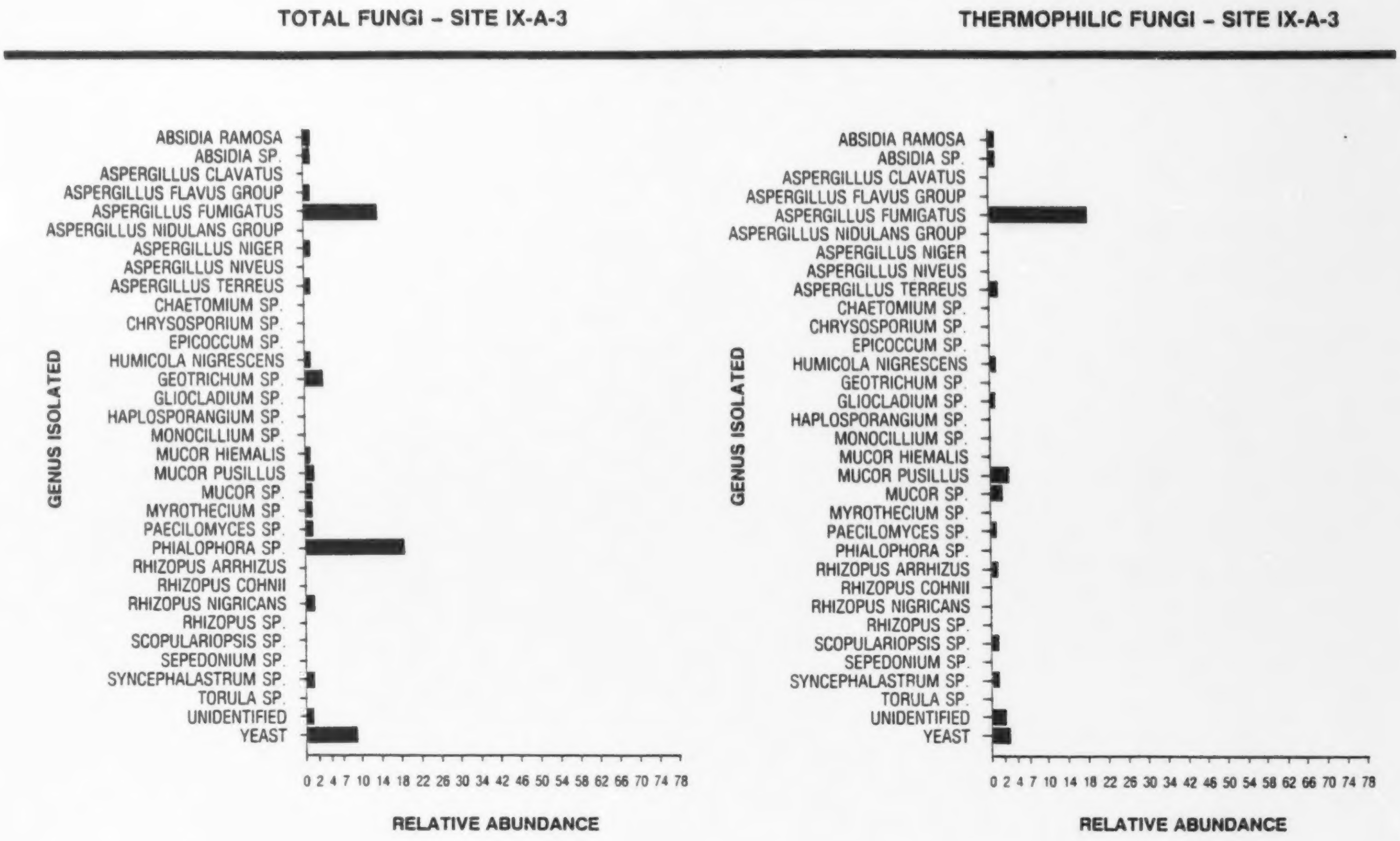


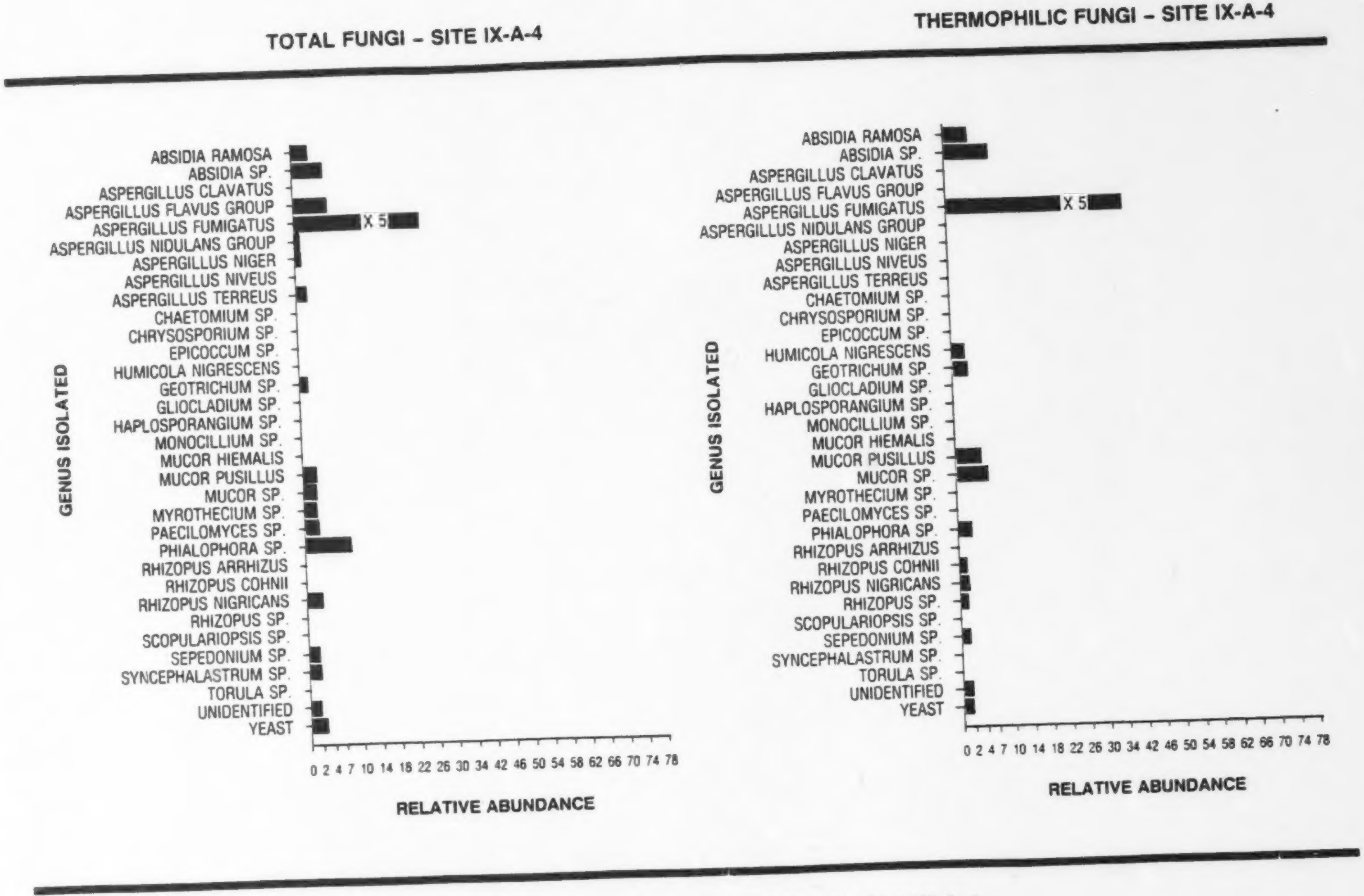
Figure 9. Relative Abundance of Fungi, Site IX-A-2



TOTAL FUNGI - SITE IX-A-3

THERMOPHILIC FUNGI - SITE IX-A-3

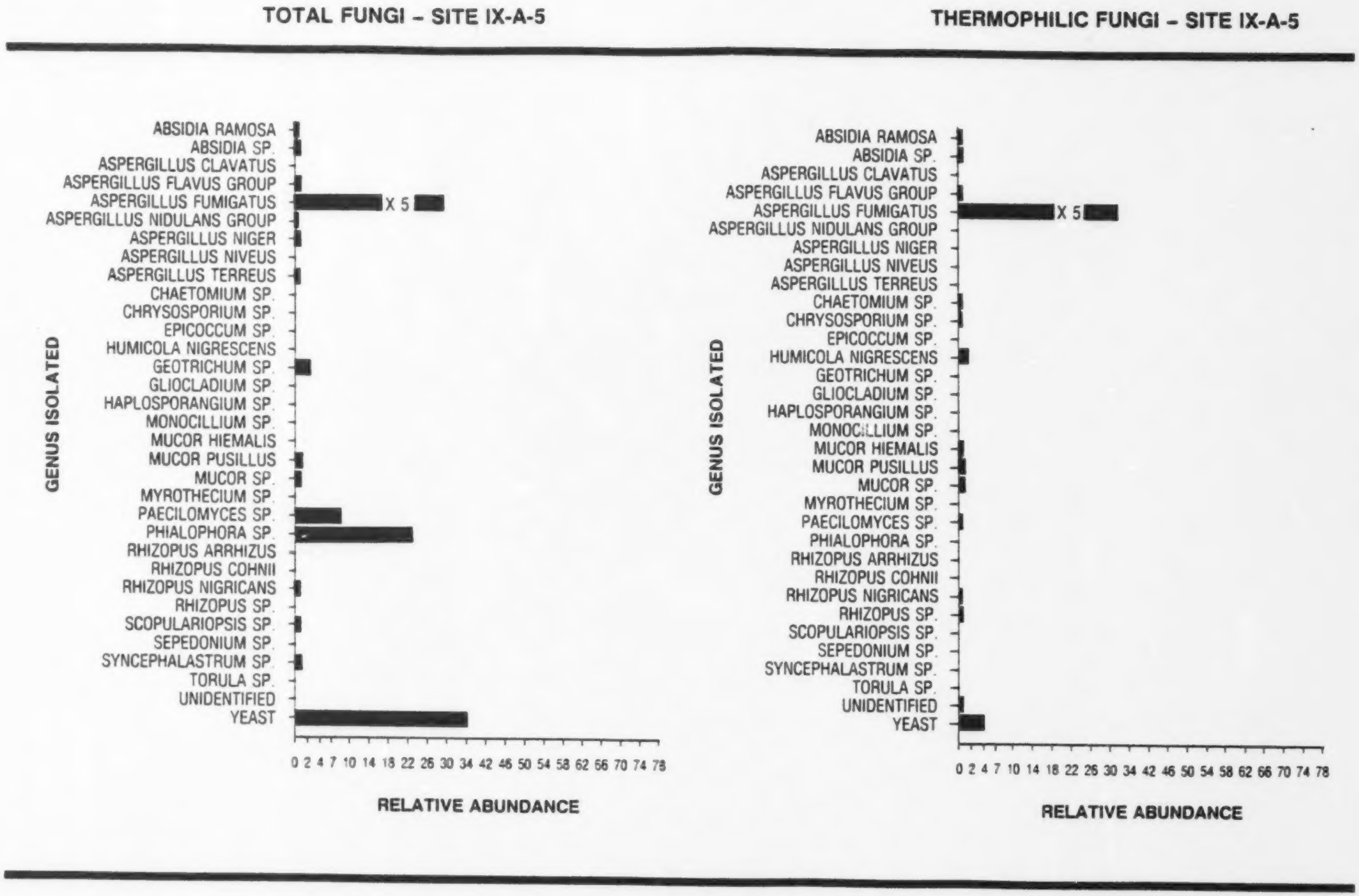
Figure 10. Relative Abundance of Fungi, Site IX-A-3



TOTAL FUNGI - SITE IX-A-4

THERMOPHILIC FUNGI - SITE IX-A-4

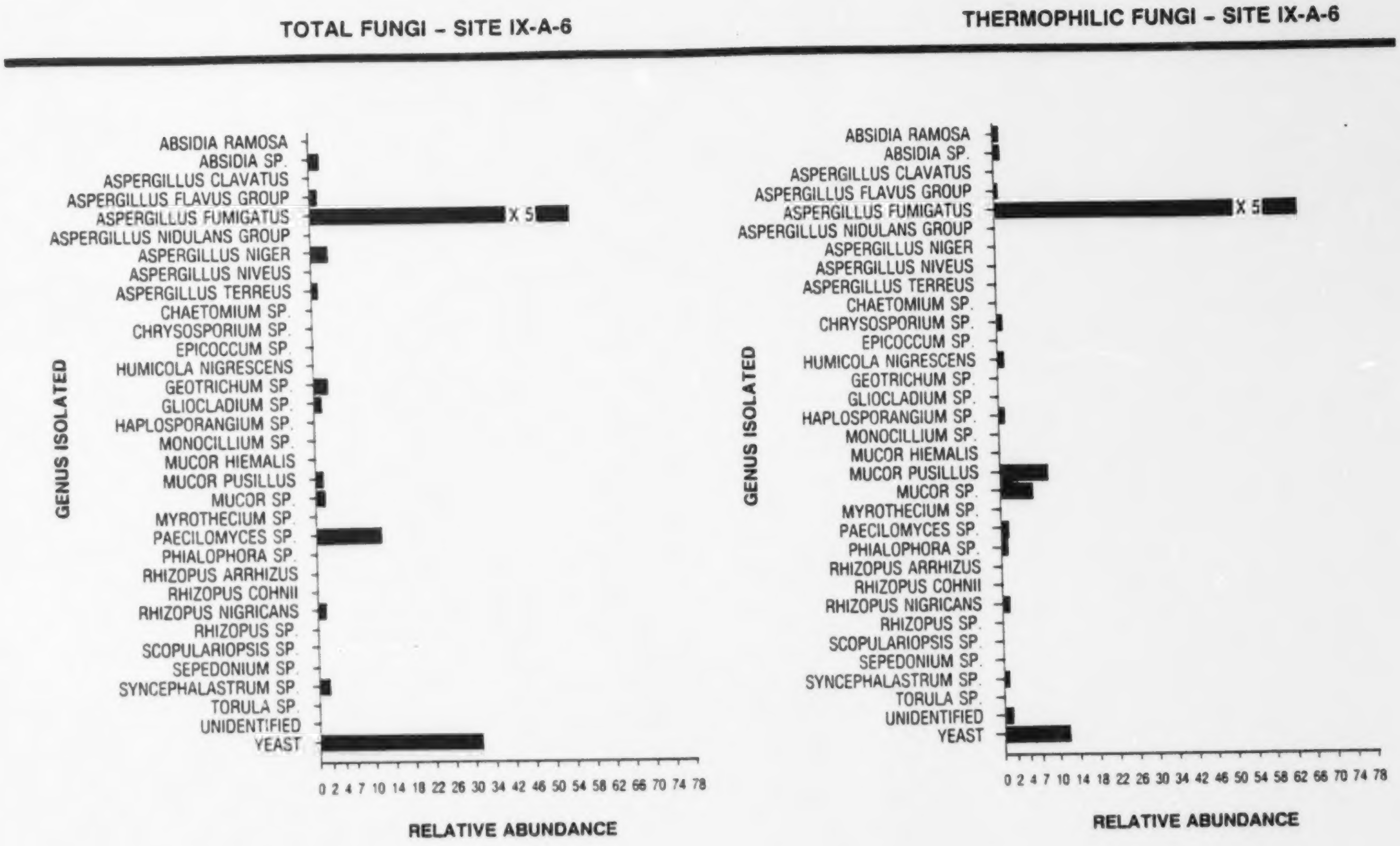
Figure 11. Relative Abundance of Fungi, Site IX-A-4



TOTAL FUNGI – SITE IX-A-5

THERMOPHILIC FUNGI – SITE IX-A-5

Figure 12. Relative Abundance of Fungi, Site IX-A-5


TOTAL FUNGI - SITE IX-A-6

THERMOPHILIC FUNGI - SITE IX-A-6

Figure 13. Relative Abundance of Fungi, Site IX-A-6

TABLE 19 TOTAL FUNGI ISOLATED FROM TOTAL FUNGI PLATE COUNT

	III-B-1		III-B-2		IX-A-1		IX-A-2	
GENUS/SPECIES	% POSITIVE SAMPLES	RELATIVE ABUNDANCE	% POSITIVE SAMPLES	RELATIVE ABUNDANCE	% POSITIVE SAMPLES	RELATIVE ABUNDANCE	% POSITIVE SAMPLES	RELATIVE ABUNDANCE
ABSIDIA RAMOSA	19	3.96	20	3.56	6	1.20		
ABSIDIA SP.	44	46	42	29	14	1.30		
ASPERGILLUS CLAVATUS								
ASPERGILLUS FLAVUS GROUP	2	1.12			9	1.10		
ASPERGILLUS FUMIGATUS	69	379	71	377	49	5.52	17	1.03
ASPERGILLUS NIDULANS GROUP								
ASPERGILLUS NIGER	2	1.00						
ASPERGILLUS NIVEUS								
ASPERGILLUS TERREUS								
CHAETOMIUM SP.	4	1.10			3	1.00		
CHRYSOSPORIUM SP.			4	1.28				
EPICOCCUM SP.	4	1.33	2	1.00				
HUMICOLA NIGRESCENS			4	1.23				
GEOTRICHUM SP.	6	1.38	9	1.83	9	1.74	11	1.18
GLIOCLADIUM SP.								
HAPLOSPORANGIUM SP.								
MUCOR HIEMALIS	8	1.62	1	1.98				
MUCOR PUSILLUS	15	6.13			9	1.04		
MUCOR SP.	23	13	9	1.81	14	1.58	6	1.00
MYROTHECIUM SP.								
PAECILOMYCES SP.	2	1.28			9	1.18		
PHIALOPHORA SP.	21	6	7	1.51	31	11.6	11	1.98
RHIZOPUS ARRHIZUS								
RHIZOPUS COHNII								
RHIZOPUS NIGRICANS								
RHIZOPUS SP.								
SCOPULARIOPSIS SP.								
SEPEDONIUM SP.								
SYCEPHALASTRUM SP.								
TORULA SP.								
UNIDENTIFIED YEAST	21	3.45	27	15	9	1.31		

TABLE 19 CONT'D. TOTAL FUNGI ISOLATED FROM TOTAL FUNGI PLATE COUNT

GENUS/SPECIES	IX-A-3 % POSITIVE SAMPLES	IX-A-3 RELATIVE ABUNDANCE	IX-A-4 % POSITIVE SAMPLES	IX-A-4 RELATIVE ABUNDANCE	IX-A-5 % POSITIVE SAMPLES	IX-A-5 RELATIVE ABUNDANCE	IX-A-6 % POSITIVE SAMPLES	IX-A-6 RELATIVE ABUNDANCE
ABSIDIA RAMOSA	6	1.19	12	2.28	2	1.03		
ABSIDIA SP.	6	1.13	27	4.53	6	1.36	14	1.81
ASPERGILLUS CLAVATUS								
ASPERGILLUS FLAVUS GROUP	2	1.20	35	6.27	14	1.45	8	1.44
ASPERGILLUS FUMIGATUS	58	13.4	68	121	71	146	74	267
ASPERGILLUS NIDULANS GROUP			2	1.00	2	1.00		
ASPERGILLUS NIGER	4	1.06	4	1.07	8	1.26	20	2.38
ASPERGILLUS NIVEUS			4	1.23				
ASPERGILLUS TERREUS	2	1.03	8	1.64	2	1.07	4	1.00
CHAETOMIUM SP.								
CHRYSOSPORIUM SP.								
EPICOCCUM SP.								
HUMICOLA NIGRESCENS	2	1.10						
GEOTRICHUM SP.	12	2.30	4	1.40	14	2.56	10	2.37
GLIOCLADIUM SP.							2	1.07
HAPLOSPORANGIUM SP.								
MUCOR HIEMALIS	2	1.00	2	1.00				
MUCOR PUSILLUS	12	1.42	18	2.25	11	1.48	4	1.24
MUCOR SP.	6	1.14	14	2.00	8	1.16	6	1.52
MYROTHECIUM SP.	2	1.05					4	1.7
PAECILOMYCES SP.	8	1.29	14	2.07	35	7.06	37	12
PHIALOPHORA SP.	40	17.2	20	8.43	48	22	33	13
RHIZOPUS ARRHIZUS								
RHIZOPUS COHNII								
RHIZOPUS NIGRICANS	2	1.04	12	1.69	4	1.08	2	1.05
RHIZOPUS SP.								
SCOPULARIOPSIS SP.					2	1.01		
SEPEDONIUM SP.			2	1.21				
SYCEPHALASTRUM SP.	2	1.20	6	1.39	4	1.05	8	1.49
TORULA SP.								
UNIDENTIFIED	2	1.11	2	1.19				
YEAST	44	9.41	10	2.48	46	34	39	32

TABLE 20 THERMOPHILIC FUNGI ISOLATED FROM THERMOPHILIC FUNGI PLATE COUNT

GENUS/SPECIES	III-B-1		III-B-2		IX-A-1		IX-A-2	
	% POSITIVE SAMPLES	RELATIVE ABUNDANCE	% POSITIVE SAMPLES	RELATIVE ABUNDANCE	% POSITIVE SAMPLES	RELATIVE ABUNDANCE	% POSITIVE SAMPLES	RELATIVE ABUNDANCE
ABSIDIA RAMOSA	23	6.56	20	4.43	9	1.35		
ABSIDIA SP.	44	65	44	55	14	1.59		
ASPERGILLUS CLAVATUS	2	1.20						
ASPERGILLUS FLAVUS GROUP								
ASPERGILLUS FUMIGATUS	81	1545	78	521	48	10.3	11	1.13
ASPERGILLUS NIDULANS GROUP					3	1.06		
ASPERGILLUS NIGER								
ASPERGILLUS NIVEUS								
ASPERGILLUS TERREUS					3	1.06		
CHAETOMIUM SP.					3	1.00		
CHRYSOSPORIUM SP.	6	1.60	13	2.15	11	1.65		
EPICOCCUM SP.								
HUMICOLA NIGRESCENS	8	1.87	7	1.39	8	1.64		
GEOTRICHUM SP.	27	7.66	13	3.21	17	2.73	1	1.00
GLIOCLADIUM SP.								
HAPLOSPORANGIUM SP.	2	1.05						
MUCOR HIEMALIS								
MUCOR PUSILLUS	4	1.38	7	1.45	6	1.17		
MUCOR SP.	25	9.80	22	7.28	8	1.31	1	1.18
MYROTHECIUM SP.								
PAECILOMYCES SP.								
PHIALOPHORA SP.	4	1.46						
RHIZOPUS ARRHIZUS								
RHIZOPUS COHNII								
RHIZOPUS NIGRICANS	2	1.00						
RHIZOPUS SP.			2	1.00				
SCOPULARIOPSIS SP.								
SEPEDONIUM SP.			2	1.10				
SYCEPHALASTRUM SP.								
TORULA SP.					14	1.86		
UNIDENTIFIED	6	1.23	7	1.83	8	1.47		
YEAST	10	3.25	2	1.24	6	1.22		

TABLE 20 CONT'D. THERMOPHILIC FUNGI ISOLATED FROM THERMOPHILIC FUNGI PLATE COUNT

GENUS/SPECIES	IX-A-3		IX-A-4		IX-A-5		IX-A-6	
	% POSITIVE SAMPLES	RELATIVE ABUNDANCE	% POSITIVE SAMPLES	RELATIVE ABUNDANCE	% POSITIVE SAMPLES	RELATIVE ABUNDANCE	% POSITIVE SAMPLES	RELATIVE ABUNDANCE
ABSIDIA RAMOSA	3	1.15	12	3.13	4	1.09	6	1.30
ABSIDIA SP.	3	1.15	31	7.12	13	1.41	10	1.39
ASPERGILLUS CLAVATUS								
ASPERGILLUS FLAVUS GROUP					2	1.06	4	1.18
ASPERGILLUS FUMIGATUS	54	16.7	70	183	81	161	78	322
ASPERGILLUS NIDULANS GROUP								
ASPERGILLUS NIGER								
ASPERGILLUS NIVEUS								
ASPERGILLUS TERREUS	2	1.07						
CHAETOMIUM SP.					2	1.06		
CHRYSOSPORIUM SP.					2	1.16	2	1.00
EPICOCCUM SP.								
HUMICOLA NIGRESCENS	2	1.08	2	1.07	6	1.33	2	1.25
GEOTRICHUM SP.	6	1.31	10	1.79	4			
GLIOCLADIUM SP.	2	1.01						
HAPLOSPORANGIUM SP.							2	1.10
MUCOR HIEMALIS					2	1.14		
MUCOR PUSILLUS	8	2.17	29	3.93	10	1.35	27	7.51
MUCOR SP.	13	1.61	18	5.49	10	1.47	25	4.76
MYROTHECIUM SP.								
PAECILOMYCES SP.	2	1.00			4	1.15	8	1.57
PHIALOPHORA SP.			2	1.18			4	1.31
RHIZOPUS ARRHIZUS	2	1.14						
RHIZOPUS COHNII			2	1.00				
RHIZOPUS NIGRICANS			10	1.30	2	1.00	4	1.07
RHIZOPUS SP.			4	1.10	2	1.05		
SCOPULARIOPSIS SP.								
SEPEDONIUM SP.	2	1.09	2	1.10				
SYCEPHALASTRUM SP.							2	1.02
TORULA SP.								
UNIDENTIFIED	10	1.56	4	1.26	4	1.05	4	1.41
YEAST	15	2.81	4	1.21	13	3.59	25	12

The indicator data were divided into subsets based on the calendar seasons and tested for significant differences. Unfortunately other events occurred that confounded the data and make it difficult to determine the cause of any observed effects. For example, the method of composting was changed at the windrow facility during the late summer and fall periods. During that period little sawdust was used; recycled compost was the predominant bulking agent. Mean indicator concentrations were lower during the summer and fall but it is not clear if season (climatic conditions) or composting procedure was the significant variable.

The static pile facility data were also examined for seasonality. The climatic variation from season to season was more pronounced at this site. Again differences were detected but the observed variations were not logical. Other operational factors appeared to confound any seasonal effects. Although seasonality may be a factor during composting, it was not possible to isolate seasonal effects as independent variables affecting indicator populations during the course of this study.

Pathogenic bacteria

Salmonellae--

Salmonella sp. were detected regularly in compost products from both of the facilities. Salmonellae data are summarized in Table 21. The populations of salmonellae followed patterns similar to those observed for the indicator bacteria. At the static pile facility, the number of samples with detectable levels of salmonellae was notably less from the giveaway bin compared to the screened compost. The average concentration of salmonellae was also significantly lower in the giveaway bin samples. This difference remained significant when the data were adjusted for the variation in wood chip content.

The occurrence of salmonellae in the samples from the windrow facility was different from that at the static pile site. Few salmonellae were detected in the finished compost from the windrow facility (IX-A-1 and IX-A-2). The same was true of the bagged product that contained only screened compost (IX-A-3). On the few occasions that salmonellae were detected in IX-A-3, the levels were quite low. In contrast, the bagged products IX-A-4, IX-A-5 and IX-A-6 which contained mixtures of compost and amendments, frequently contained salmonellae and often at relatively high concentrations. The mean concentrations of salmonellae shown in Table 21 only marginally reflect the increased number of positive samples from the amended compost. Although the mean concentrations for the amended products (IX-A-4, IX-A-5 and IX-A-6) were higher than the unamended material, the mean concentrations were still relatively low. The same is true for the mean concentrations of salmonellae at the two static pile sites, III-B-1 and III-B-2. Table 22, which shows how these *Salmonella* populations were distributed, gives a different perspective to the data. In the case of site III-B-2, sixteen percent of the samples contained salmonellae at a level greater than 10,000 MPN/g. Applying this figure to the annual production at that site would estimate that 34,000 dry tons of compost were distributed which contained greater than 10,000 salmonellae per gram. When applied to the bagged products IX-A-5 and IX-A-6, the data in Table 17 would predict that approximately 193,000 bags of product contained greater than 1,000 salmonellae per gram and 26,000 bags of product contained greater than 10,000 salmonellae per gram based on proprietary marketing data.

The occurrence of salmonellae in these samples was much greater than expected. Studies conducted at Beltsville detected salmonellae in only four of 31 compost samples from 30 facilities (Hussong et al 1985). With one exception the concentrations were very low. The apparent difference between their results and these data may be due to either one or both of two factors. First, this study concentrated much more intensive sampling at two facilities. If only one sample had been collected from each of the sampling points in this study, there is a reasonable probability that little or no salmonellae would have been detected. The extent of the

Table 21 Occurrence of Salmonella at Weekly Sites

Site	% Samples Positive	Mean MPN/g	Range MPN/g
III-B-1	48	1	<0.1 - 8,700
III-B-2	80	44	<0.1 - 85,000
IX-A-1	8	<0.2	<0.1 - 34
IX-A-2	0	<0.2	N.A.
IX-A-3	17	<0.2	<0.1 - 1400
IX-A-4	47	0.7	<0.1 - 720
IX-A-5	69	7	<0.1 - 8,800
IX-A-6	65	10	<0.1 - 16,000

Table 22 Percentage of Samples Containing Salmonellae Concentrations Greater Than Given Log. Increments

MPN/g	Percent							
	III-B-1	III-B-2	IX-A-1	IX-A-2	IX-A-3	IX-A-4	IX-A-5	IX-A-6
>DL[a]	48	80	8	0	17	47	69	65
>1	40	78	6	0	15	41	62	59
>10	27	64	3	0	6	24	58	53
>100	20	42	0	0	4	6	27	37
>1,000	4	27	0	0	2	0	10	20
>10,000	0	16	0	0	0	0	2	2
>100,000	0	0	0	0	0	0	0	0

a > detection limit of test, 0.2 MPN/g

salmonellae presence was only revealed by the large number of samples spread over a long period of time.

Second, the laboratory methods used in the two studies may also have been a factor. Hussong et al (1985) and this laboratory both found conventional methods inadequate for quantifying salmonellae in sludge and compost. Both laboratories developed modified methods which have been described elsewhere (Hussong et al 1985, Walker and Yanko 1987). The salmonellae procedures used in these two studies were quite different and may have been a factor in the results; however, the respective methods had not been compared for this study.

The pattern of salmonellae isolations is somewhat difficult to explain and to some extent, contradictory. Site III-B-2 at the static pile facility which represented the final compost product, contained the highest levels of salmonellae. It is unknown if these salmonellae initially survived the high temperature aeration phase or if the population was reduced during the aeration stage and then regrew during the curing/storage period or if the compost was contaminated by external sources after production. *Salmonella* regrowth would not be consistent with the Beltsville data (Hussong et al 1985) that demonstrated salmonellae seeded into compost died off at a fairly rapid rate. If the earlier assertion that the material in the giveaway bin, on average, represented older compost, the lower concentrations of salmonellae in the bin would be consistent with the Beltsville research. Subsequent contamination of the compost by animals (rodents, birds) after production was not evaluated in this study.

On the other hand, results from the windrow facility clearly suggest regrowth of salmonellae. The finished compost from the windrow contained very little salmonellae, as was also the case with the bagged product containing only screened compost. When rice hulls or forest by-products were added to the compost and aged, the salmonellae populations increased in the final products. This increase occurred concurrent with increases in the indicator bacteria, heterotrophic plate count populations and fungal populations, contrary to the conclusions of Hussong *et al* (1985) that the active indigenous flora of compost establishes a barrier to colonization by salmonellae.

This project concentrated on testing only end products; however other research at the windrow facility (Hay 1986) examined microbial populations in the amendment materials (rice hulls and forest byproducts) and found high coliform populations but no salmonellae. Although contamination at the bagging facility was found to be a probable factor, nutrient related regrowth was the only plausible explanation for the high levels of salmonellae detected in many of the modified compost products (Hay 1986).

The laboratory experiments by Russ and Yanko (1981) demonstrated regrowth of indigenous salmonellae in compost in the presence of the competing microbial populations; the effect was transient and die off subsequently occurred. The Beltsville research (Hussong *et al* 1985) showed regrowth in irradiation sterilized compost but die off occurred in untreated compost when seeded with laboratory cultures of *S. typhimurium* and *S. newport*. Perhaps the apparent difference between these studies is related to the specific salmonellae involved. This project and the laboratory experiments by Russ and Yanko (1981) identified *Salmonella* only to the genus level. The salmonellae species measured may have been those that had already survived anaerobic digestion and composting and may have been better adapted than laboratory cultures to compete with the indigenous flora in compost. Another possible explanation for the differnces in the results may relate to the experimental design itself. Although composting does not sterilize compost, it is probable that all mesophilic nonsporeforming bacterial populations are greatly reduced during the high temperature phase. The simultaneous seeding of sterile compost with coliforms and salmonellae, as in the Beltsville experiments (Hussong et al 1985), may actually approximate the population distribution of these organisms immediately following thermophilic composting. At that point it is unlikely that salmonellae populations would have been selectively reduced while coliform populations remain high. Given appropriate conditions, the salmonellae and coliforms, as well as other mesophilic populations, may regrow at the same time. If the other populations increased without an increase in salmonellae, the indigenous populations would then probably inhibit salmonellae as suggested by Hussong *et al* (1985). The key question is why salmonellae repopulation appears to occur in some cases and not others. Salmonellae repopulation is clearly a phenomenon that needs to be better understood in order to be properly managed.

In viewing the individual salmonellae results tabulated in Appendix C, two trends were noted. Salmonellae isolations occurred regularly at the giveaway bin (III-B-1) with no discernible pattern whereas isolations from the screened compost (III-B-2) increased dramatically from August through December. In contrast, salmonellae isolations occurred much more frequently in the bagged products (IX-A-4, IX-A-5 and IX-A-6) from January through July but decreased notably from August through December. These observed changes did not correlate with any apparent seasonal factors.

Operational changes occurred at both of the facilities that may have been related to the patterns of salmonellae isolations. The static pile composting facility was physically relocated in the spring of the project year. In addition, the facility experienced a municipal employee strike during the summer at which time the composting operation was not monitored as closely as usual.

At the windrow facility, more stringent guidelines, including laboratory testing, were instituted for determining when a composted windrow was to be released to the commercial producer. The commercial producer also used sludges from other sources and it is not known which sludges were contained in bags of final product, further confounding data analysis at this site.

The actual effect of these various factors is unsubstantiated but may have been significant. In any case, the results suggest that some form of monitoring may be necessary to detect changes and and assure product quality. This subject will be discussed later in the report.

Although some salmonellae were higher than would be considered desirable, no consistent overt health hazard was apparent considering estimated infective doses for Salmonella infections. Use of these compost products in home vegetable gardens however, may increase exposure risk. It is also not known what infective doses may be applicable to young children, the elderly or immunologically suppressed individuals.

Rates of Salmonella infections have been increasing in the United States in recent years. Salmonellosis clearly remains a disease of concern. Nevertheless, the salmonellae are fairly ubiquitous and it is common knowledge that salmonellae may be found in food products such as chicken and turkey. The WHO (1981) has suggested that it may be impossible to eliminate salmonellae from the environment and that the best control measures may be increased education about food handling practices.

It is difficult to assess the potential health significance of the salmonellae detected in the compost products. There are no known cases of salmonellosis traceable to the use of sludge based soil amendments. The studies by Ottolenghi *et al* (1987) found no apparent risk to farm families using anaerobically digested sludges in agricultural applications. These sludges were shown to contain salmonellae. Available data suggest that salmonellae may persist in sludge amended soil for up to five months but that a 90% reduction occurs within three weeks (Sorber and Moore 1986). There is some evidence that specific *Salmonella* serotypes may selectively grow in compost and that these strains are less commonly associated with clinical infections (unpublished data).

All of these factors appear to mitigate the health significance of the salmonellae data. At the same time the question raised by these results should not be ignored. Additional research to better understand the reasons for the high salmonellae levels is warranted. Relatively simple management practices may significantly alleviate any potential hazards associated with salmonellae in compost.

Yersinia --

The genus name *Yersinia* is used here to refer to *Yersinia enterocolitica* and closely related species. *Yersinia* data for the weekly sites are summarized in Table 23. There was a significant difference between the two facilities sampled weekly for yersiniae isolations. *Yersinia* were isolated infrequently and only at low levels from finished compost and bagged compost samples at the windrow facility. High concentrations of *Yersinia* were observed in many of the static pile samples. The mean concentrations of *Yersinia* at III-B-1 and III-B-2 were not very high when averaged over the year; however, the pattern of isolations was consistent with an hypothesized seasonal occurrence. The seasonality of the data is depicted in Figure 14 where it can be seen that the *Yersinia* populations were high during the winter and spring months and were not detectable in summer and early fall months. It is unknown if the *Yersinia* occurred seasonally in the sewage or if they proliferated at some point in the treatment process. Langland (1983) suggested that *Yersinia* may grow in sewage sludge since it was more frequently isolated in stored sludge. It would seem plausible that the ability of the *Yersinia* to grow at low temperatures was related to the occurrence of the organism during periods of cold weather. Temperature may also have been a factor in the absence of *Yersinia* at the windrow facility which was located in a more temperate climatic region.

Table 23 Occurrence of Yersinia at Weekly Sites

SITE	% Samples Positive	Mean MPN/g	Range MPN/g
III-B-1	27	0.6	<0.1 - 54,000,000
III-B-2	42	6	<0.1 - 2,500,000
IX-A-1	3	<0.2	<0.1 - 0.7
IX-A-2	0	<0.2	N.A.
IX-A-3	2	<0.2	<0.1 - 1
IX-A-4	6	<0.2	<0.1 - 3.3
IX-A-5	4	<0.2	<0.1 - 2.4
IX-A-6	2	<0.2	<0.1 - 0.6

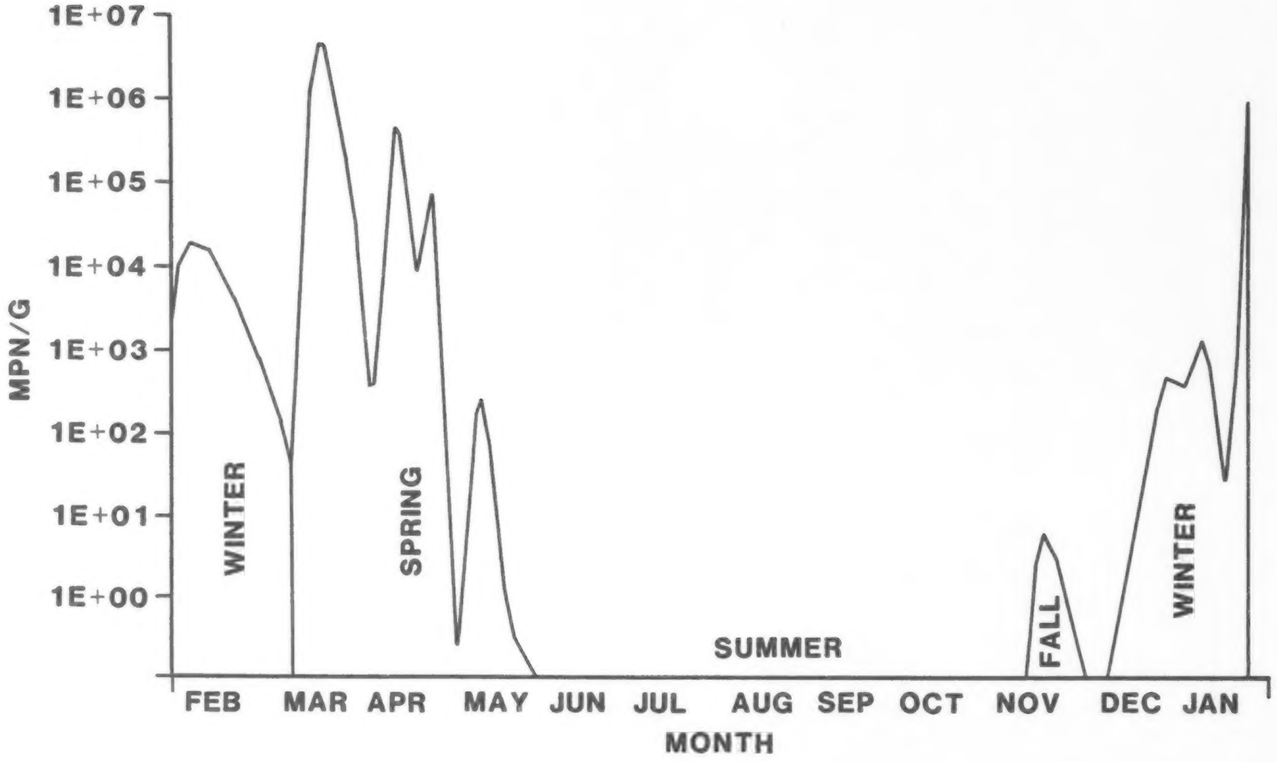


FIGURE 14 SEASONAL VARIATION OF YERSINIA ISOLATED FROM SITE III-B-2

The fate of *Yersinia enterocolitica* in compost and dried sludge was unknown and only limited information was available about the occurrence of *Yersinia* in sludges. Seattle researchers (Metro 1983) reported high levels (10^6-10^9 per g wet weight) of *Yersinia enterocolitica* in anaerobically digested sludges and suggested the prevalent biotypes were avirulent. Langeland (1983) isolated *Y. enterocolitica*, *Y. intermedia*, *Y. kristensenii* and other *Yersinia* from 51% of 35 samples of stored sewage sludge. The isolates belonged to 17 different serogroups, but 42% of the cultures were non-typable. The serogroups most commonly associated with disease, 0:3, 0:8 and 0:9 were not detected. Langeland's data underscores one of the difficulties in evaluating the *Yersinia* results. Most environmental strains of *Y. enterocolitica* are avirulent but disease outbreaks have been associated with environmental sources (Shayegani 1986). With large numbers of *Yersinia* present in sludge or compost, these materials could constitute a reservoir of pathogenic *Yersinia* strains.

The laboratory tests used to isolate and enumerate the yersiniae do not discriminate between virulent and non-virulent strains. Virulence is governed by chromosomally determined characteristics and related to the presence of a plasmid. In vitro and in vivo tests for characteristics associated with pathogenicity are available but were outside the scope of this study. Nevertheless, the large numbers of *Yersinia* detected in some samples clearly presented a concern that needed to be addressed. The New York State Department of Health (NYSDOH), which had previously conducted studies examining environmental reservoirs of pathogenic *Yersinia* (Shayegani 1986), agreed to characterize a number of *Yersinia* isolates from this project. Results of these tests are shown in Table 24.

Twenty-eight randomly selected cultures from the static pile composting sites were thoroughly characterized using 36 biochemical tests and were serogrouped with antisera 0:1 through 0:34 prepared in the NYSDOH laboratory. Seventeen were identified as *Y. enterocolitica*, seven as *Y. kristensenii*, two as *Y. frederiksenii* and two as *Y. intermedia*. Most of the *Y. enterocolitica* cultures were serologically non-groupable. Three representative cultures of the non-groupable *Y. enterocolitica*, the two serogrouped *Y. enterocolitica* and one serogrouped *Y. frederiksenii* were tested for pathogenicity markers. None of the isolates were positive in the pathogenicity tests summarized in Table 25. The non-serogroupable strains of *Y. entrocolitica* are not usually considered pathogenic.

For a project of this magnitude it was necessary to use a shortened confirmation scheme in order to adapt *Yersinia* isolation techniques to a quantitative multiple tube procedure. Although abbreviated, it was originally thought that the quantitative method used for this study was reasonably specific for *Y. enterocolitica*, as indicated in the literature cited for the methods (Weagant 1983 a&b). The comprehensive identification of isolates performed by

Table 24 Identification of Random *Yersinia* Isolates from Static Pile Compost Samples

Sample Date	Site	Isolate No.	Identification	Serogroup
02/01/86	III-B-2	1	*Y. enterocolitica*	NG
		2	*Y. intermedia*	NG
03/14/86	III-B-2	1	*Y. enterocolitica*	NG
		2	*Y. kristensenii*	0:19
03/21/86	III-B-2	1	*Y. frederiksenii*	0:16,29
03/28/86	III-B-1	1	*Y. enterocolitica*	NG
		2	*Y. kristensenii*	0:11,23,24
03/28/86	III-B-2	1	*Y. frederiksenii*	0:16,29
04/25/86	III-B-1	1	*Y. kristensenii*	0:11,23,24
		2	*Y. kristensenii*	0:11,23,24
11/24/86	III-B-1	1	*Y. enterocolitica*	NG
		2	*Y. enterocolitica*	NG
		3	*Y. enterocolitica*	NG
		4	*Y. intermedia*	0:4,16,20
12/01/86	III-B-1	1	*Y. kristensenii*	0:11,24
		2	*Y. kristensenii*	0:11,24
12/23/86	III-B-2	1	*Y. enterocolitica*	NG
		2	*Y. enterocolitica*	NG
		3	*Y. enterocolitica*	NG
		4	*Y. kristensenii*	0:29
12/30/86	III-B-2	1	*Y. enterocolitica*	NG
		2	*Y. enterocolitica*	NG
		3	*Y. enterocolitica*	0:4,33
		4	*Y. enterocolitica*	0:14
		5	*Y. enterocolitica*	NG
		6	*Y. enterocolitica*	NG
		7	*Y. enterocolitica*	NG
01/06/87	III-B-2	1	*Y. enterocolitica*	NG

NG = not groupable

Table 25 Pathogenicity Testing of Selected *Yersinia* Isolates

Isolate	Identification		Pathogenicity Tests AA	CaDep	HeLa	Mice	Plasmid
03/14/86 III-B-2#1	*Y. enterocolitica*	NG	-	-	ND	-	14Md
03/21/86 III-B-2#1	*Y. frederiksenii*	0:16,29	-	-	-	-	-
03/28/86 III-B-1#1	*Y. enterocolitica*	NG	-	-	-	-	-
12/23/86 III-B-2#1	*Y. enterocolitica*	NG	-	-	-	-	-
12/30/86 III-B-2#3	*Y. enterocolitica*	0:4,33	-	-	-	-	-
12/30/86 III-B-2#4	*Y. enterocolitica*	0:14	-	-	-	-	-

AA - Autoagglutination at 37 C

CaDep - Calcium dependence at 37 C

HeLa - HeLa cell adherence

Mice - Mouse lethality with 10^5 bacteria injected intraperitoneally

Plasmid - 42 megadalton plasmid considered responsible for pathogenicity

NG - nongroupable

ND - not done

NYSDOH revealed that the quantitative test measured *Y. enterocolitica*, *Y. kristensenii*, *Y. frederiksenii* and *Y. intermedia*. The apparent reason for the discrepancy is that the taxonomy of the *Yersinia* group is fairly recent. The other species identified by NYSDOH were, until recently, considered part of the *Y. enterocolitica* group, usually categorized as atypical or unusual *Y. enterocolitica* (Bergey's Manual, 1984). This discrimination, however, is reasonably significant because the pathogenic strains are in the true *Y. enterocolitica*. The other species, *Y. kristensenii*, *Y. frederiksenii* and *Y. intermedia*, are considered non-pathogenic environmental organisms.

The citrate (Simmons) test at 25 C included in the screening procedures should have eliminated *Y. intermedia*. The fact that NYSDOH did identify some isolates as *Y. intermedia* probably reflected the more extensive characterization and an atypical citrate reaction. The addition of a Voges-Proskauer test at 25 C and an acid from rhamnose reaction to the confirmation tests used during this study would have more reliably limited the measured population to *Y. enterocolitica*. However, extensive biochemical testing would be necessary to completely assure the accuracy of each identification.

The characterization of *Yersinia* isolates performed by NYSDOH suggests that the high levels of this organism detected at the static pile site probably do not constitute a public health risk, but the number of isolates actually tested was very small relative to the quantity of *Yersinia* measured in some compost samples. These data do not definitively establish that virulent *Y. enterocolitica* were not present or that sludges do not serve as a reservoir of pathogenic *Yersinia* strains. Additional research will be necessary to fully address these questions and understand the ecology of yersiniae in affected sludge treatment systems.

Toxigenic _E_. _Coli_ --

A relatively small number of toxigenic strains of _E_. _coli_ were detected. A total of 14 toxigenic _E_. _coli_ were isolated from all six of the windrow facility sampling sites and 3 toxigenic cultures were detected in samples from the static pile facility.

Table 26 Enterotoxigenic _E_. _coli_ Positive Samples from Weekly Sites

Site	Date	# Toxigenic Isolates	Fecal Coliform Log MPN/g
III-B-I	06-17-86	1	7.184
	10-27-86	1	2.419
	11-24-86	1	2.431
IX-A-2	11-06-86	1	2.851
IX-A-3	06-12-86	2	1.294
	07-24-86	2	1.475
	11-13-86	2	4.176
	12-04-86	1	2.602
IX-A-4	02-20-86	1	5.990
	09-18-86	1	6.146
IX-A-5	06-26-86	2	7.157
IX-A-6	05-22-86	1	7.637
	01-22-87	1	5.204

Quantitatively, it appeared the toxigenic strains represented an insignificant portion of the fecal coliform population. It was originally thought that toxigenic strains, if present, would probably represent a relatively small fraction of the _E_. _coli_ population. For that reason only fecal coliform tubes resulting from the largest inoculum (10mL) of the coliform MPN test were tested for the presence of toxigenic _E_. _coli_. The positive fecal coliform tubes were streaked to Endo agar and five typical _E_. _coli_ colonies were picked and tested for toxin production. If all five colonies were toxin negative, the original MPN tube was considered negative for the MPN titer. When all three of the 10mL inoculum tubes were negative for toxin producing strains, as was usually the case, it was indicated that toxigenic *E. coli* populations were less than the detection limit of the test.

Reexamination of the data suggests that this approach may have grossly underestimated the levels of toxigenic *E. coli*. If the results are expressed as percentage of *E. coli* colonies that were toxigenic, a substantially different population estimate results. A total of 3,915 E. coli colonies from windrow facility sample were tested and 14 were toxin positive (0.36%); 1395 colonies from the static pile facility samples were tested and 3 were positive (0.22%). Data from the bi-monthly sampled facilities, which will be discussed later in the report, revealed that 0.375 of these colonies were toxin positive. These percentages were all relatively close; an average of 0.32% of slightly more than 7000 *E. coli* colonies picked were toxigenic strains. If one assumes the fecal coliform test measured predominantly E. coli populations and multiples the mean fecal coliform results by the average percentage of toxigenic colonies, the estimated numbers of toxigenic *E. coli* were significantly higher than originally reported (Appendix C), as shown in Table 27.

Table 27 Mean Toxigenic *E. coli* Levels
Estimated by Percentage Toxin Positive Colonies
Times Fecal Coliform Counts

Possible Toxigenic *E. coli* Densities - MPN/g							
III-B-1	III-B-2	IX-A-1	IX-A-2	IX-A-3	IX-A-4	IX-A-5	IX-A-6
390	10,000	0.5	0.05	5.4	140	1400	10,000

It would appear that the Table 27 estimates may be a more accurate assessment of the levels of toxigenic *E. coli* and that the original procedure was inadequate to detect these levels. Given that the toxigenic *E. coli* represent approximately 0.3% of the total E. coli and that the fecal coliforms were predominately *E. coli*, the initial inoculum in a coliforms MPN test would contain a ratio of toxigenic *E. coli* to fecal coliforms of approximately 1:300. Again, assuming the populations all grow at the same rate in the lauryl tryptose medium and in EC medium, thus maintaining the 1:300 ratio when streaked to the Endo agar, picking 5 colonies would result in 60:1 odds against selecting a toxigenic colony.

It became apparent that the original procedure for quantifying the toxigenic *E. coli* could not have enumerated a level of 0.3% toxigenic strains. However, 0.3% of the tested colonies were toxin positive and therefore, it is reasonable to assume that 0.3% of the *E. coli* populations were toxigenic.

The estimates in Table 27 were based on the assumption that the fecal coliform test measured predominantly *E. coli*. Unfortunately fecal coliform populations were not characterized during the course of the study. Even if only half the fecal coliforms were *E. coli*, the density of toxigenic strains would still be high in some samples. Considering the relatively high densities of fecal coliforms occurring in some samples, it appears additional research would be warranted to address potential helath risks associated with toxigenic *E. coli*.

Campylobactor--

There have been no published reports on the detection of indigenous Campylobactor in seweage or sludge. However, this organism is a significant cause of human enteritis and there are numerous animal reservoirs for the infection as well (Blaser and Keller 1981). Therefore, since it is likely that this enteric bacterial pathogen is entering sewage, attempts were made to detect it in the D & M products.

No Campylobacter were isolated during the course of this study, however the available methodology for detecting campylobacters in compost proved to be relatively inadequate. As described in Appendix A, experiments with Campylobacter seeded into compost suspensions estimated a detection limit of approximately 1000 CFU/ml. This translates to a detection limit of approximately 20,000 CFU per dry gram of compost. All attempts to improve recovery (described in Appendix A) were unsuccessful. Ottolenghi and Hamparian (1987) reported recovering seeded Campylobacter from anaerobically digested sludge and estimated a detection limit of approximately 150 CFU/ml based on two tests. It is not known why lower levels of seeded Campylobacter could be recovered from the liquid sludges, but it may be related to characteristics of the sludges compared to compost suspensions used in the respective seeding experiments or to differences in the C. jejuni cultures used for seeding. Ottoleghi and Hamparian (1987) used a clinical isolate and this study used an ATCC culture.

Essentially all Campylobacter seeded omtp sterile compost suspensions could be recovered indicating the compost was not innerently toxic to the C. jejuni. The enrichment media and Campy Blood Agar medium did not appear to be selective enough to allow low levels of Campylobacter to be detected in the presence of the background compost populations.

Although Ottolenghi and Hamparian (1987) were able to detect somewhat lower levels of seeded Campylobacter, they isolated no Campylobacter spp. from 99 samples of sludge. These authors concluded that the high sensitivity of this organism to oxygen make its presence highly unlikely in aerobically digested sludges. The same would certainly be true of aerobic composting systems which present an even more hostile environment. Considering the relatively fastidious nature of Campylobacter and its susceptibility to drying (Doyle and Roman 1982), it is extremely doubtful that Campylobacter spp. would persist through any composting or sludge drying process.

Enterbacteriaceae--

The quantitative values for the undifferentiated total enteric plate counts were included with the data summaries of the indicator groups (Table 6 - 13). The primary purpose of this test however, was to screen for enteric pathogenic bacteria that might have been present in large numbers but were not texted with dedicated procedure. A number of colonies were picked from the countable dilution of the enteric plate count and identified with the Minitek Systems, a commerically available clinical test kit. The limitations of this approach are discussed in Appendix A.

Sixty-eight different species or groups of bacteria were identified which were almost equally divided between the Enterobacteriaceae and the non-fermenter groups. These data are not quantitative per se, but the relative occurrence of isolates can be distributed by isolation frequency. Figures 15 through 22 show the relative occurrence of bacterial isolated from the sample sites at the windrow and static pile composting facilities. The data are summarized numberically in Tables 28 and 29. In general, the majority of bacteria detected were pseudomonads. Beyond that, the other dominant genera and relative occurrence ratios varied providing further evidence that these samples contained active microflora that adapted and changed with conditions. In addition to the pseudomonads, the dominant genera isolated were *Acinetobacter*, *Alcaligenes*, *Achromobacter* and *Moraxella*. The validity of the *Moraxella* identifications is somewhat weak. The identification of these bacteria is based more on the absence of reactions rather than its ability to utilize specific substrates. There are alos a number of groups of unnamed bacteria that closely resemble *Moraxella* (Lennete 1974). There is a reasonable probability that the isolates could have been *Pseudomonas diminuta* or other *Pseudomonas* species. For purposes of this study the differentiation is moot; any of the potential variants would be considered of low pathogenicity and opportunistic pathogens at best.

The same is basically true of most of the bacteria regularly identified during the enteric screening. Many may be opportunistic pathogens but none are associated with endemic or epidemic disease. Early in the study a few isolates were identified as shigellae. At first it was considered surprising, but not impossible that a *Shigella* would be detected. Subsequently, more cultures were identified as shigellae and the validity of the identifications was questioned. Additional testing confirmed that these isolates were not shigellae. The first few isolates had been discarded before the additional tests were instituted and therefore, were not confirmed as Shigella. Considering that all subsequent isolates which were identified as shigellae by Minitek were subsequently shown to be other organisms, it is highly unlikely that the earlier, discarded isolates were *Shigella*. The difficulties of adapting clinical test kits to testing environmental isolates and the Shigella problem is discussed in greater detail in Appendix A.

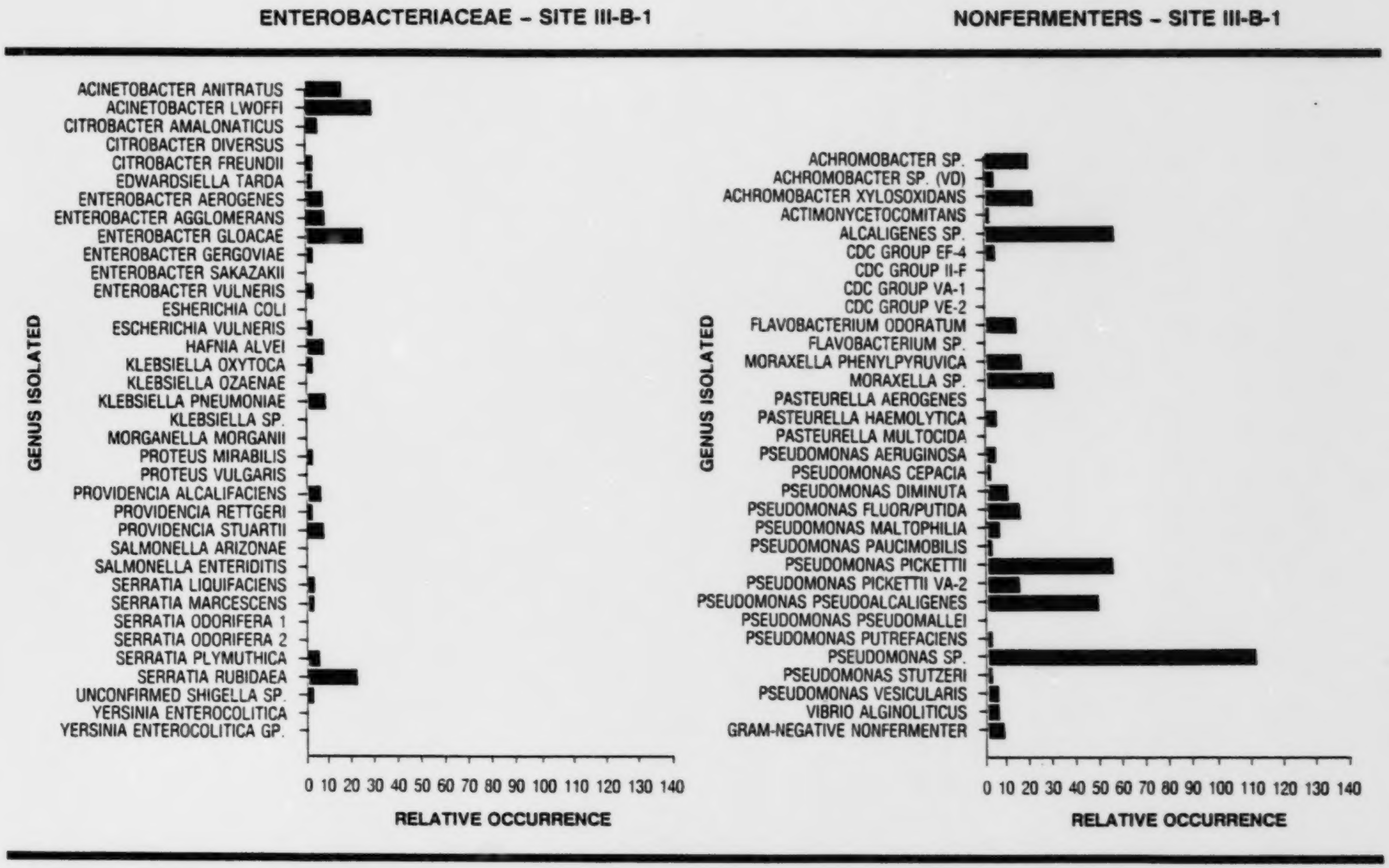


Figure 15. Relative Occurrence of Total Enteric Bacteria, III-B-1

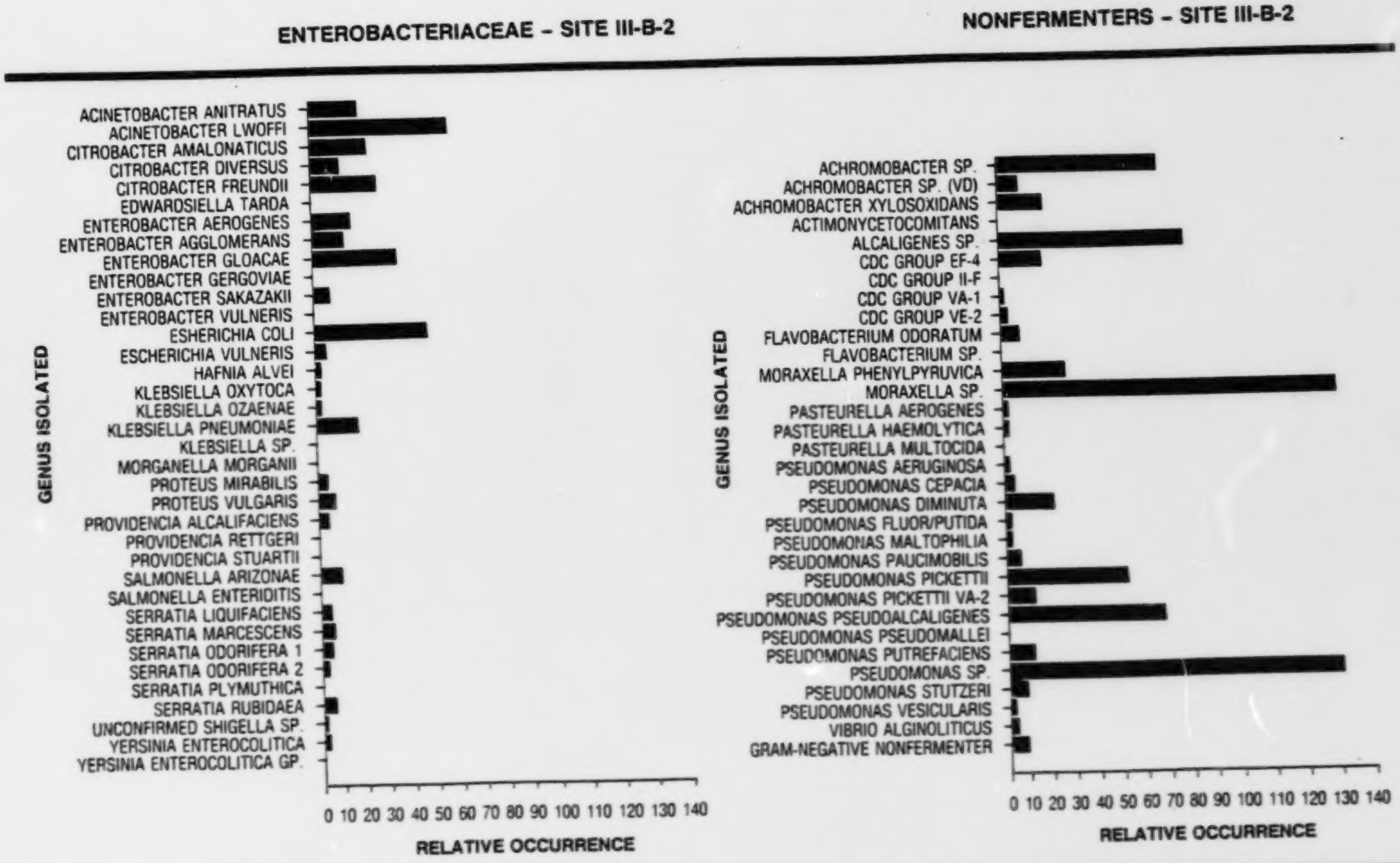
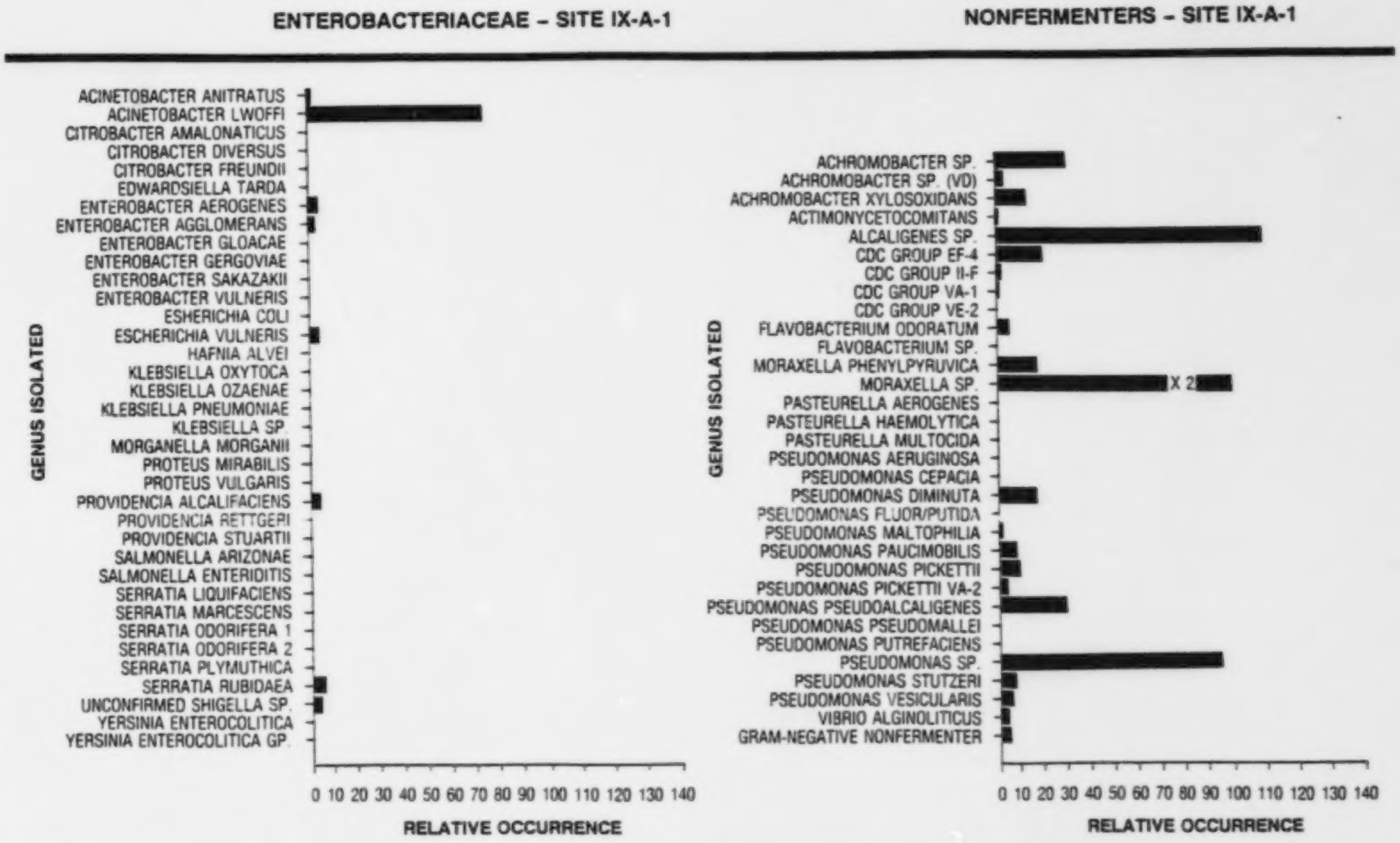


Figure 16. Relative Occurrence of Total Enteric Bacteria, III-B-2



ENTEROBACTERIACEAE – SITE IX-A-1

NONFERMENTERS – SITE IX-A-1

Figure 17. Relative Occurrence of Total Enteric Bacteria, IX-A-1

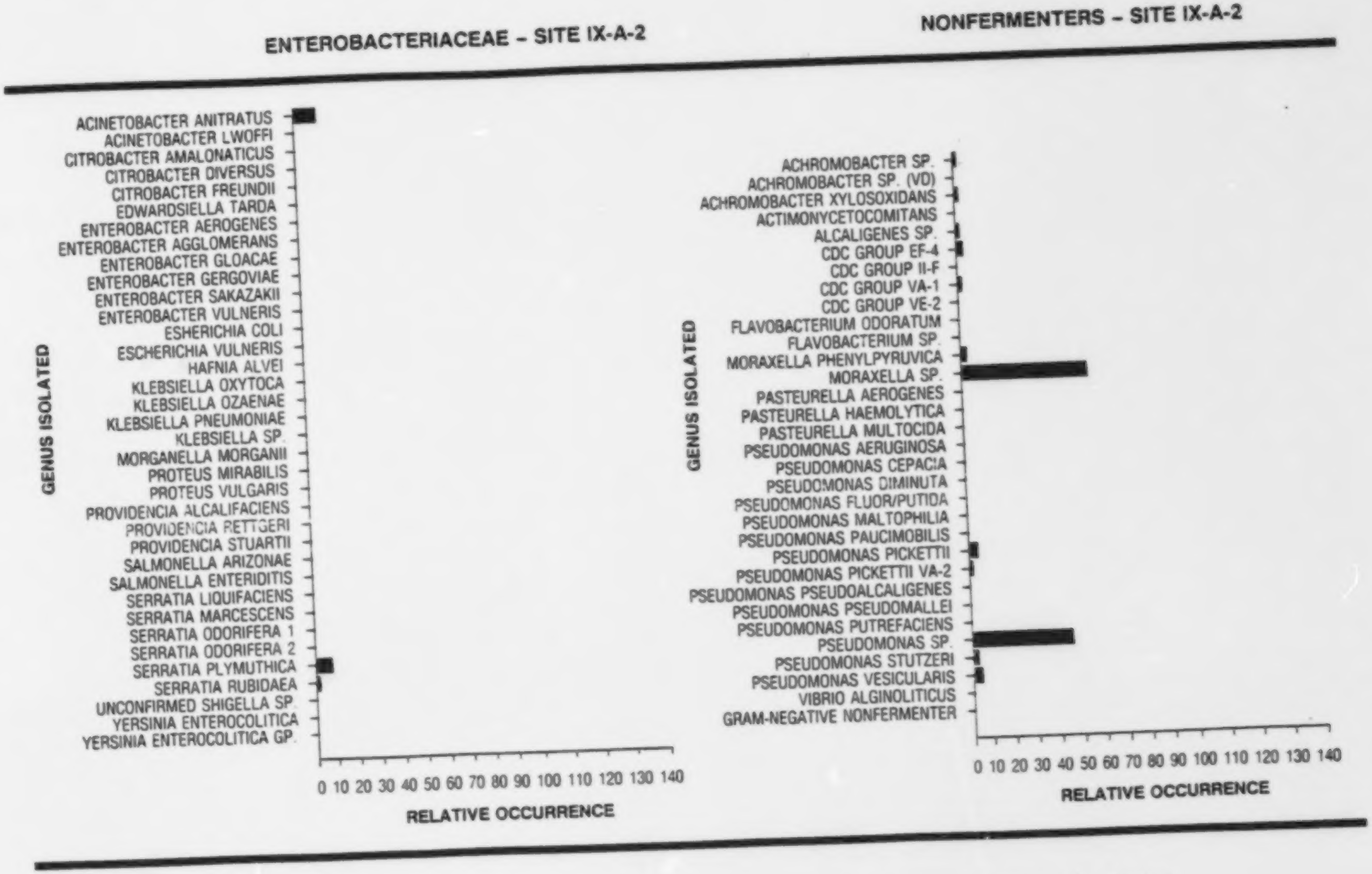


Figure 18. Relative Occurrence of Total Enteric Bacteria, IX-A-2

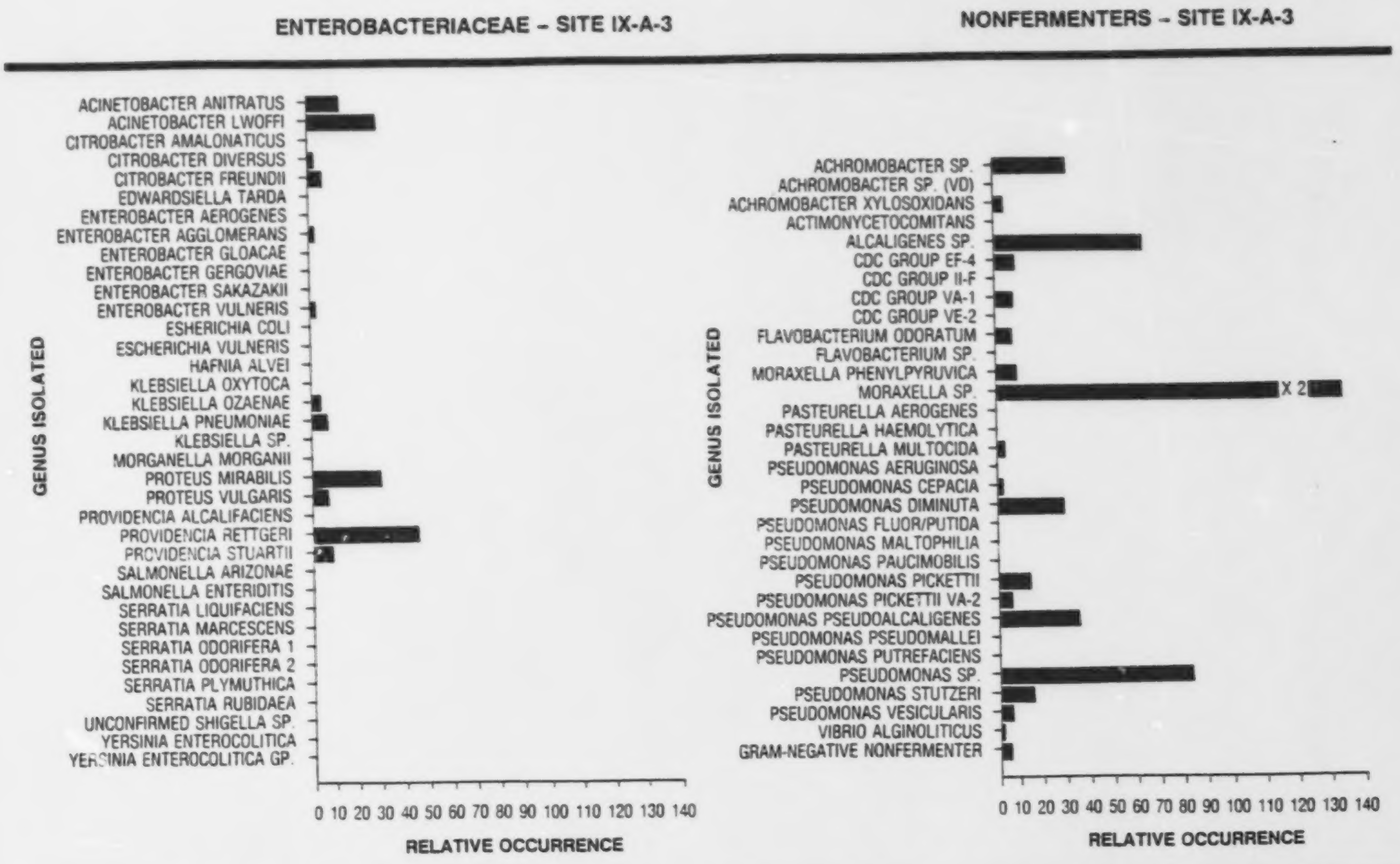


Figure 19. Relative Occurrence of Total Enteric Bacteria, IX-A-3

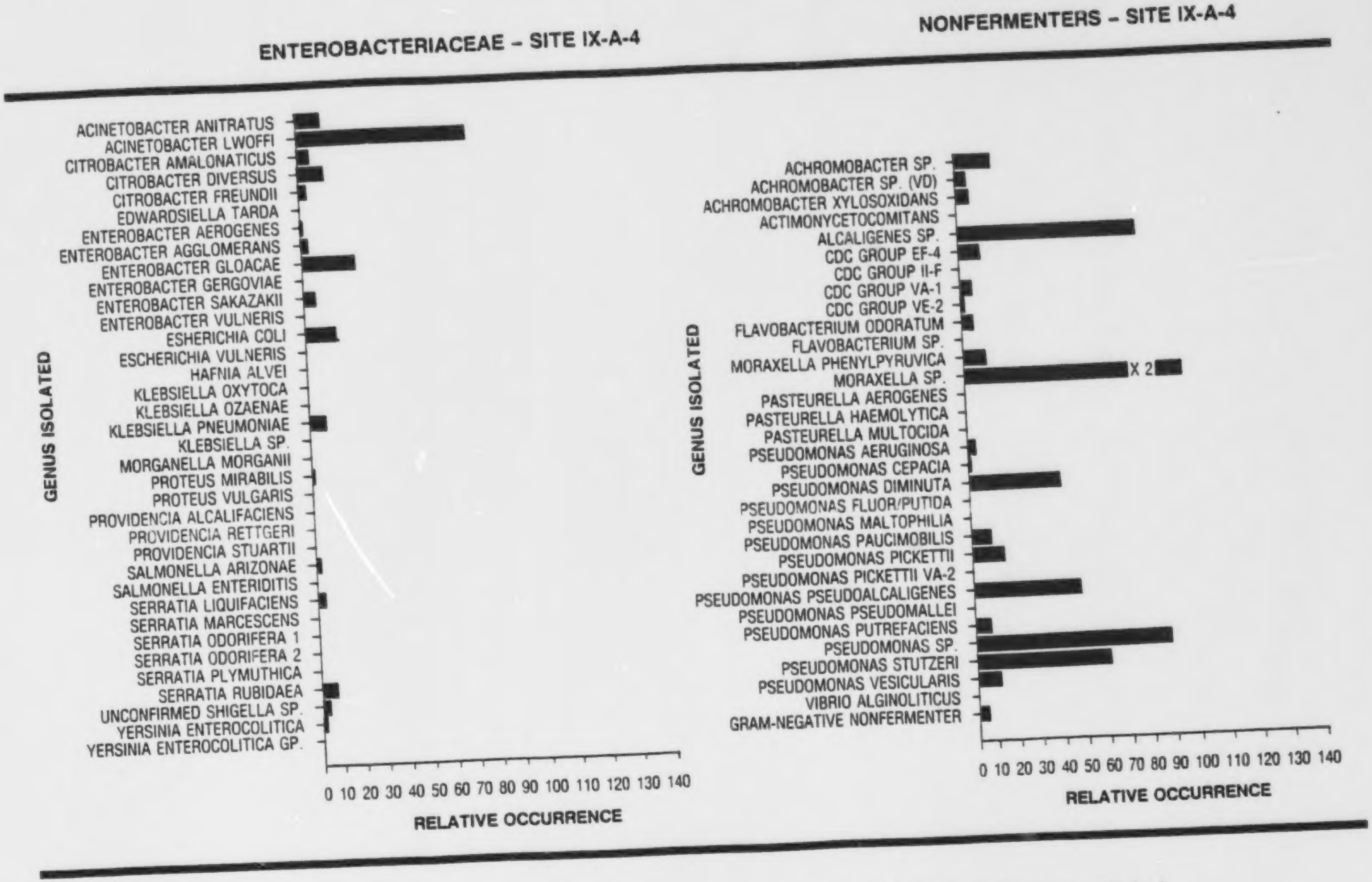
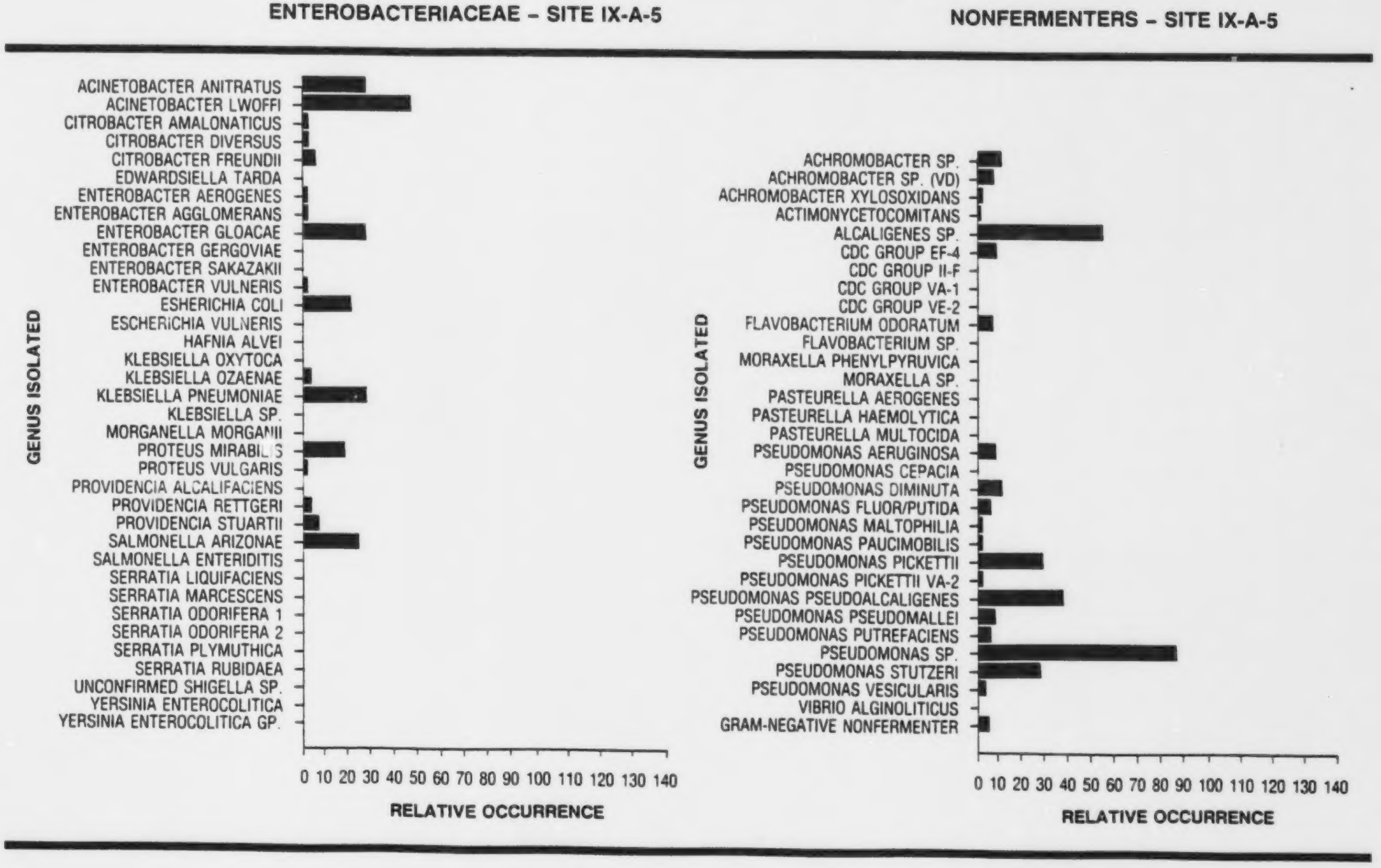


Figure 20. Relative Occurrence of Total Enteric Bacteria, IX-A-4



ENTEROBACTERIACEAE - SITE IX-A-5

NONFERMENTERS - SITE IX-A-5

Figure 21. Relative Occurrence of Total Enteric Bacteria, IX-A-5

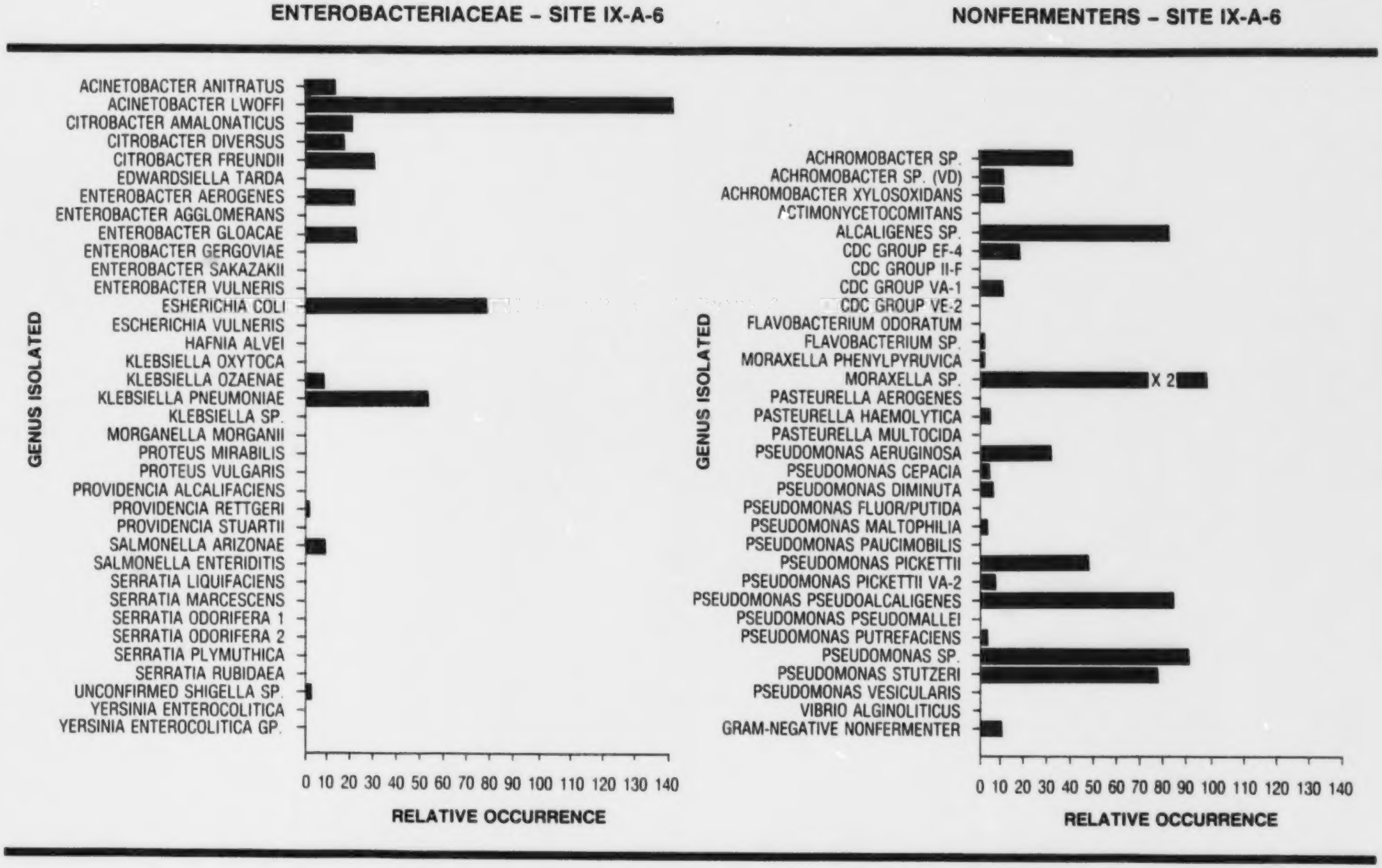


Figure 22. Relative Occurrence of Total Enteric Bacteria, IX-A-6

TABLE 28 ENTEROBACTERIACEAE ISOLATED FROM TOTAL ENTERIC PLATE COUNT

GENUS/SPECIES	III-B-1		III-B-2		IX-A-1		IX-A-2	
	% POSITIVE SAMPLES	RELATIVE OCCURRENCE	% POSITIVE SAMPLES	RELATIVE OCCURRENCE	% POSITIVE SAMPLES	RELATIVE OCCURRENCE	% POSITIVE SAMPLES	RELATIVE OCCURRENCE
ACINETOBACTER ANITRATUS	17	16	11	20	3	1		
ACINETOBACTER LWOFFI	21	27	42	58	30	76	11	8
CITROBACTER AMALONATICUS	4	5	16	24				
CITROBACTER DIVERSUS			4	12				
CITROBACTER FREUNDII	2	2	18	32				
EDWARDSIELLA TARDA	2	2						
ENTEROBACTER AEROGENES	8	6	9	16	3	3		
ENTEROBACTER AGGLOMERANS	12	7	9	14	3	2		
ENTEROBACTER CLOACAE	23	22	22	36				
ENTEROBACTER GERGOVIAE	2	2						
ENTEROBACTER SAKAZAKII	2	14	4	8				
ENTEROBACTER VULNERIS	2	2			3	3		
ESCHERICHIA COLI			18	48				
ESCHERICHIA VULNERIS	2	1	4	4				
HAFNIA ALVEI	4	5						
KLEBSIELLA OXYTOCA	2	1	2	2				
KLEBSIELLA OZANAE			2	2				
KLEBSIELLA PNEUMONIAE	8	7	16	16				
KLEBSIELLA SP.								
MORGANELLA MORGANII								
PROTEUS MIRABILIS	2	1	2	4				
PROTEUS VULGARIS			4	7				
PROVIDENCIA ALCALIFACIENS	4	4	4	4				
PROVIDENCIA RETTGERI	2	1			3	3		
PROVIDENCIA STUARTII								
SALMONELLA ARIZONAE	4	6	4	9				
SALMONELLA ENTERIDITIS								
SERRATIA LIQUIFACIENS			4	4				
SERRATIA MARCESCENS	2	2	4	5				
SERRATIA ODORIFERA 1			4	4				
SERRATIA ODORIFERA 2			4	2				
SERRATIA PLYMUTHICA	4	3					6	6
SERRATIA RUBIDAEA	23	22	7	4	3	5	6	1
UNCONFIRMED SHIGELLA SP.	2	2	2	1	3	3		
YERSINIA ENTEROCOLITICA			2	2				
YERSINIA ENTEROCOLITICA GP.								

TABLE 28 CONT'D. ENTEROBACTERIACEAE ISOLATED FROM TOTAL ENTERIC PLATE COUNT

GENUS/SPECIES	IX-A-3		IX-A-4		IX-A-5		IX-A-6	
	% POSITIVE SAMPLES	RELATIVE OCCURRENCE	% POSITIVE SAMPLES	RELATIVE OCCURRENCE	% POSITIVE SAMPLES	RELATIVE OCCURRENCE	% POSITIVE SAMPLES	RELATIVE OCCURRENCE
ACINETOBACTER ANITRATUS	6	10	4	7	13	25	8	11
ACINETOBACTER LWOFFI	27	23	38	73	27	47	33	143
CITROBACTER AMALONATICUS			4	4	2	2	12	20
CITROBACTER DIVERSUS	2	2	6	10	2	2	8	14
CITROBACTER FREUNDII	4	4	2	3	6	5	18	30
EDWARDSIELLA TARDA								
ENTEROBACTER AEROGENES			2	1	2	2	12	21
ENTEROBACTER AGGLOMERANS			4	3	2	2		
ENTEROBACTER CLOACAE	2	2	14	24	17	25	12	22
ENTEROBACTER GERGOVIAE								
ENTEROBACTER SAKAZAKII			4	5				
ENTEROBACTER VULNERIS					2	2		
ESCHERICHIA COLI	2	2	10	14	12	20	29	78
ESCHERICHIA VULNERIS								
HAFNIA ALVEI								
KLEBSIELLA OXYTOCA	4	3						
KLEBSIELLA OZANAE	6	6			2	4	8	9
KLEBSIELLA PNEUMONIAE			10	8	17	30	29	52
KLEBSIELLA SP.								
MORGANELLA MORGANII								
PROTEUS MIRABILIS	12	29	2	1	4	16		
PROTEUS VULGARIS	6	6			2	1		
PROVIDENCIA ALCALIFACIENS					2	1		
PROVIDENCIA RETTGERI	21	46			4	2	2	1
PROVIDENCIA STUARTII	4	9			8	5		
SALMONELLA ARIZONAE			2	2			4	10
SALMONELLA ENTERIDITIS								
SERRATIA LIQUIFACIENS			4	4				
SERRATIA MARCESCENS								
SERRATIA ODORIFERA 1								
SERRATIA ODORIFERA 2								
SERRATIA PLYMUTHICA								
SERRATIA RUBIDAEA			4	8				
UNCONFIRMED SHIGELLA SP.			2	3			2	2
VERSINIA ENTEROCOLITICA			2	2				
VERSINIA ENTEROCOLITICA GP.								

TABLE 29 NONFERMENTERS ISOLATED FROM TOTAL ENTERIC PLATE COUNT

GENUS/SPECIES	III-B-1		III-B-2		IX-A-1		IX-A-2	
	% POSITIVE SAMPLES	RELATIVE OCCURRENCE	% POSITIVE SAMPLES	RELATIVE OCCURRENCE	% POSITIVE SAMPLES	RELATIVE OCCURRENCE	% POSITIVE SAMPLES	RELATIVE OCCURRENCE
ACHROMOBACTER SP.	21	19	33	68	17	31	6	1
ACHROMOBACTER SP.	4	3	7	9	3	3		
ACHROMOBACTER XYLOSOXIDANS	29	21	16	19	6	12	11	1
ACTINOMYCETOCOMITANS	2	1			3	1		
ALCALIGENES SP.	48	56	51	79	44	111	6	1
CDC GROUP EF-4	4	3	13	18	8	19	11	2
CDC GROUP II-F					3	2		
CDC GROUP VA-1			2	2	3	1	10	1
CDC GROUP VE-2			2	2				
FLAVOBACTERIUM ODORATUM	15	12	7	8	6	5		
FLAVOBACTERIUM SP.								
MORAXELLA PHENYLPYRUVICA	19	14	22	26	14	15	11	2
MORAXELLA SP.	25	29	58	129	61	198	72	56
PASTEURELLA AEROGENES			2	2				
PASTEURELLA HAEMOLYTICA	6	4	2	2	3	3		
PASTEURELLA MULTOCIDA								
PSEUDOMONAS AERUGINOSA								
PSEUDOMONAS CEPACIA	2	1	2	4				
PSEUDOMONAS DIMINUTA	10	9	16	21	17	15		
PSEUDOMONAS FLUOR/PUTIDA	6	14	2	2				
PSEUDOMONAS MALTOPHILIA	4	5	2	2	3	2		
PSEUDOMONAS PAUCIMOBILIS	2	2	7	6	8	8		
PSEUDOMONAS PICKETTII	40	53	33	52	14	10	6	3
PSEUDOMONAS PICKETTII VA-2	15	13	4	11	3	3	6	1
PSEUDOMONAS PSEUDOALCALIGENES	52	49	42	68	19	30		
PSEUDOMONAS PSEUDOMALLEI								
PSEUDOMONAS PUTREFACIENS	2	1	4	11				
PSEUDOMONAS SP.	67	112	49	134	56	187	72	44
PSEUDOMONAS STUTZERI	2	1	7	8	6	7	11	2
PSEUDOMONAS VESICULARIS	6	5	2	2	8	6	6	3
VIBRIO ALGINOLITICUS	6	5	2	3	3	3		
GRAM-NEGATIVE NONFERMENTER	8	7	7	7	6	4		

TABLE 29 CONT'D. NONFERMENTERS ISOLATED FROM TOTAL ENTERIC PLATE COUNT

GENUS/SPECIES	IX-A-3		IX-A-4		IX-A-5		IX-A-6	
	% POSITIVE SAMPLES	RELATIVE OCCURRENCE	% POSITIVE SAMPLES	RELATIVE OCCURRENCE	% POSITIVE SAMPLES	RELATIVE OCCURRENCE	% POSITIVE SAMPLES	RELATIVE OCCURRENCE
ACHROMOBACTER SP.	27	34	14	18	14	13	20	38
ACHROMOBACTER SP.			6	6	6	9	6	11
ACHROMOBACTER XYLOSOXIDANS	6	4	8	7	2	2	8	11
ACTINOMYCETOCOMITANS					2	1		
ALCALIGENES SP.	31	64	45	80	38	53	39	83
CDC GROUP EF-4	10	8	8	10	10	10	10	17
CDC GROUP II-F								
CDC GROUP VA-1	4	6	6	6			4	10
CDC GROUP VE-2			2	2				
FLAVOBACTERIUM ODORATUM	8	6	2	5	6	5		
FLAVOBACTERIUM SP.							2	2
MORAXELLA PHENYLPYRUVICA	8	7	14	11	19	20	4	2
MORAXELLA SP.	77	268	65	192	77	240	57	196
PASTEURELLA AEROGENES								
PASTEURELLA HAEMOLYTICA							2	6
PASTEURELLA MULTOCIDA	2	2						
PSEUDOMONAS AERUGINOSA			4	4				
PSEUDOMONAS CEPACIA	2	1	2	2			2	4
PSEUDOMONAS DIMINUTA	25	30	14	40	10	11	4	6
PSEUDOMONAS FLUOR/PUTIDA					4	4		
PSEUDOMONAS MALTOPHILIA					2	2	2	3
PSEUDOMONAS PAUCIMOBILIS			4	8	2	2		
PSEUDOMONAS PICKETTII	10	13	16	14	14	29	24	46
PSEUDOMONAS PICKETTII VA-2	8	6	6	7	2	2	4	7
PSEUDOMONAS PSEUDOALCALIGENES	17	33	33	47	25	36	41	86
PSEUDOMONAS PSEUDOMALLEI					4	8		
PSEUDOMONAS PUTREFACIENS			8	7	4	6	2	3
PSEUDOMONAS SP.	36	84	37	89	50	88	51	183
PSEUDOMONAS STUTZERI	23	16	41	63	25	29	39	79
PSEUDOMONAS VESICULARIS	8	7	8	9	4	4		
VIBRIO ALGINOLITICUS	2	1						
GRAM-NEGATIVE NONFERMENTER	6	5	4	5	6	5	6	11

Examining Figures 15-22 does illustrate the dynamic nature of the bacterial populations. Site IX-A-2 samples, which consist of compost only, show the lowest diversity and fewer bacterial dominate the population. IX-A-1 samples contained sawdust during the composting process; bacterial diversity and dominant species both increased. The commercially bagged products, IX-A-3 through IX-A-6 continue to increase in diversity and number as more species are represented in the dominant portions of the populations.

An obvious drawback to the total enteric procedure was that it only detected those bacteria occurring in greatest numbers. The total enteric plate counts were reasonably consistent throughout the study averaging approximately 10^8 CFU/g (Tables 6 - 13). After a sample was diluted to the countable range for the plate count, an enteric pathogen present at levels of 10^1 to 10^5 CFU/g would not likely be detected. This was illustrated by the Salmonella and Yersinia data. These organisms were detected frequently in substantial numbers with dedicated test procedures; however, they were seldon detected in the total enteric assay.

In general the total enteric test provided some information about the diversity of the predominant non-fermenter and Enterobacteriaceae populations in compost but was of little value for assessing potential risks from pathogenic enteric bacteria.

Parasites

Helminth ova were detected regularly in samples from both the windrow composting facility and the static pile facility. The most common ova detected were *Trichuris* and *Ascaris*, in that order. Overall, 74% of the windrow site samples were positive for *Trichuris* and 45% contained *Ascaris* ova. The static pile samples were 49% positive for *Trichuris* and 38% contained *Ascaris*. *Toxocara* and *Hymenolepis* ova were observed infrequently in samples from both facilities. No other ova or protozoan cysts were detected. Ova densities in positive samples ranged from 0.1 to 2 ova/g dry weight.

Measurements of the size of the *Trichuris* ova indicated that many of these ova were of non-human origin. There are many different species of *Trichuris* which are generally considered host specific. The ova produced by adult *Trichuris* sp. are structurally similar but often vary in size (Levine 1980). For example *Trichuris trichiura* ova, the human parasite, measure 50-54 x 22-23 micrometers whereas *T. campanula* ova, found in cats, average 71-81 x 31-36 micrometers. Many of the *Trichuris* ova detected were larger than those of *T. trichiura* suggesting sources other than human infections.

None of the *Ascaris* ova examined during this study were found to be viable by embryonation testing. Viability was reported only for the *Ascaris* ova listed in the data tables in Appendix C because the positive controls used to judge adequate conditions for embryonation were *Ascaris* ova. Nevertheless, *Trichuris* ova would be expected to embryonate under the same conditions and time (Kaneshiro 1985, Brown 1975). None of the examined *Trichuris* ova embryonated or showed earlier developmental stages. It can be reasonably assumed that all examined *Trichuris* ova were also non-viable.

It is not known if the almost exclusive detection of *Trichuris* and *Ascaris* ova reflects the ubiquity of these infections, the resistance of these ova to destruction, or a combination of both. The heat generated during composting processes would be expected to render ova non-viable, but the inactivated ova may still be relatively resistant to degradation within the time frame of the composting process. There is some evidence that *Trichuris* and *Ascaris* ova can persist intact longer than other helminth ova and of the two, that *Trichuris* is the hardier. Taylor (1955) reported finding larger numbers of *Trichuris* and *Ascaris* ova in fecal material excavated from a large pit that was part of Roman ruins located in Winchester, England. The material in the pit was approaching the consistency of peat. Based on other artifacts, the ruins were estimated to be 11th or early 12th century. As many as 5,700 eggs per gram of *Trichuris trichiura* and 600 of *Ascaris lumbricoides* were detected. It was suggested that the high egg count could be explained by the concentration of nonfermentable material during the passage of time and that the ratio of *Trichuris* to *Ascaris* reflected the relative ability of the ova to persist.

The absence of other helminth ova, such as any strongyloid egg, was considered due to their failure to resist disintegration.

When examining the reported parasite data tabulated in Appendix C, it is apparent that more ova were detected from January until approximately June compared to after June. This was true at both the windrow site and the static pile site suggesting the possiblity of a systematic analytical problem. No procedural changes were incorporated which would explain a decrease in recovery. Both composting facilities instituted operational changes during the course of the study which may somehow be related to the decrease in detected ova, but the apparent sudden change in recovery of ova is unexplained. An examination of ova data from the bimonthly sites during the same periods showed that fewer ova were detected during the second half of the sampling program at these sites too, however the difference was relatively insignificant.

In summary, no potential hazard from parasites was found associated with compost from either the windrow or the static pile facility. O'Donnel et al (1984) studied the survival of helminth ova seeded into sludges and tested both viability and infectivity. They reported that even if most of the eggs appeared to be nonviable, a few were still capable of causing infections in test animals. These authors were dealing with large numbers of ova that had been seeded into samples. Only a portion of the sample concentrates were examined prior to infecting the test animals. The suggestion that viability testing might not completely address potential infectivity is clearly applicable to the data developed during this study. However, in view of the large sample size, the low concentrations of indigenous ova and the complete absence of indications of viability, any theoretical risk must indeed be small.

The fact that no protozoan cysts were detected probably reflects the inability to recover these forms from compost as much their absence in the samples. Results of seeding experiments with Giardia cysts are discussed in Appendix A. Although recovery of cysts was poor, it still remains highly improbable that protozoan cysts could survive conditions capable of destroying helminth ova such as Ascaris.

Enteric Viruses

Virus testing of sludge and compost samples is very method dependent. There are two basic components to the virus test: (1) elution and concentration of the viruses, and (2) detection of the viruses. The elution/concentration procedures used during this project had been thoroughly evaluated and found particularly effective for high solids samples such as compost (Goyal et al 1984). The conventional assays performed in the project laboratory were run on two complementary cell lines using both plaque and liquid overlay procedures. The BGM cell line had been previously evaluated in this laboratory (unpublished results) and found highly receptive to indigenous viruses in sludge cake. In addition to the conventional assays, sample concentrates were also tested for rotaviruses at the University of Arizona using an immunofluorescence test procedure (Smith & Gerba 1982) and for a broad spectrum of viruses using a newly developed immunoperoxidase procedure (Payment and Trudel 1985) at the University of Quebec.

In spite of intensive efforts devoted to detecting viruses, only two indigenous virus isolates were confirmed during the study. The 5/2/86 giveaway bin sample and the 5/8/86 bagged product (IX-A-6) sample contained untypable picornavirus. Viruses were detected in six other samples but these isolates appeared to be contaminants resulting from "blind seeds" submitted to the laboratory as part of the quality assurance program. The virus isolations and quality assurance samples are compared in Table 30.

Examining the chronology of the introduction of seeded samples and the subsequent isolation of the seed strain from other samples strongly indicates laboratory contamination during the sample processing or assay procedures. It is highly unlikely that the only viruses isolated would be the same as seed virus and then only occur after the seed was used in the laboratory.

These results emphasize the importance of segregating high titered laboratory viruses from environmental samples. Even with experienced personnel, low level contamination is difficult to control. Blind spikes do have value from a quality control perspective, but in this case the problems outweighed the advantages. Other samples known to contain low levels of naturally occurring viruses could be used as positive controls for virus methods. These samples could be processed separately from other samples and still provide adequate assurance that the virus methods are working.

Discounting the apparent contaminants, only the two isolates of untypable picornavirus remain. This virus was present at a level below the quantitative limit for the plaque assay, less than 2.3 PFU/g. It was detected by the liquid overlay portion of the assay. It appeared to be an ECHO type virus since it cross reacted with a number of the ECHO antisera in the Lim Benyesh-Melnick pool (Lim et al 1960). It did not react with the

TABLE 30

TEMPORAL RELATION BETWEEN POSITIVE VIRUS SAMPLES AND SPIKED DUPLICATES

```
                                                                  PERIOD IN WEEKS THAT SAMPLE WAS PROCESSED
  DATE      SAMPLE            VIRUS        VIRUS                         AND ASSAYED IN LABORATORY
                             ISOLATED      SEEDED    2   4   6   8  10  12  14  16  18  20  22  24  26  28  30  32  34  36  38

04/29/86    III-B-1        NON TYPABLE(A)  -         |-------------------*-----------|
04/30/86    IX-A-5-DUP           +         ECHO 12   |------*|
05/08/86    IX-A-6-DUP     NON TYPABLE     -           |---------------------*-------------|
05/12/86    III-B-1-DUP          +         POLIO 1       |----------*-|
05/29/86    III-J-1           POLIO 1      -                |-------------------*-------------|
05/29/86    III-J-1-DUP          +         POLIO 1          |--------------*--------------------------------|
06/15/86    IX-A-3            POLIO 1      -                  |-----------------------*------------------------- --|
07/17/86    IX-A-4-DUP           +         COX B4    |-------*-|
08/27/86    III-B-1-DUP          +         COX B4            |---------------*-----------------------|
09/04/86    IX-A-6            COX B4       -                    |----------------------------*-------------------|
09/11/86    IX-A-4            COX B4       -                        |------------------------*-------------------|
09/25/86    IX-A-5            COX B4       -                          |-------------------------------*--|
10/06/86    III-B-1           COX B4       -                             |-------------------------------------*------------|
```

(A) CONFIRMED AS PICORNAVIRUS BY E.M. NOT TYPABLE WITH LIM POOL ANITSERA OR SPECIFIC ANTISERA FOR ECHO 12.

(*) WHEN VIRUS WAS DETECTED IN ASSAY.

(+) SEEDED SAMPLE, SEED DETECTED.

specific ECHO 11 antisera that will identify the laboratory strain.

The two untypable virus isolates and the virus contaminants were detected with the conventional tissue culture assay. No viruses were detected in project samples using the immunoperoxidase assays or the rotavirus tests performed in other laboratories. The immunoperoxidase assay did detect viruses in four of eight blind positive controls submitted along with the other samples. All positive controls contained concentrations of viruses greater than the theoretical detection limit. In one case a polio virus seed was detected with BGM cells (160 MPN/mL) but was not detected with MA-104 cells. The immunoperoxidase assay had been reported to be more sensitive than standard tissue culture tests for detecting enteroviruses from water samples (Payment and Trudel 1985). It is not known why four of the positive controls were not detected. In one case, shipping delays may have been a factor.

No rotavirus spiked samples were included with the samples for rotavirus assay. The contract laboratory, however, did run positive controls with the assays. One concentrate from anaerobically digested sludge that was shown to contain indigenous enteroviruses was included with the samples tested for rotaviruses; no rotaviruses were detected in this sample either.

Since most of the project samples were negative for viruses, it is not possible to assess the value of either the immunoperoxidase or rotavirus assays for testing compost and sludge samples. Nevertheless, considering the overall virus assay protocol, only two low level virus isolations from the approximately 500 samples collected during this study is essentially insignificant. No detectable virus hazard was found associated with composted sludge, or for that matter, any treated sludge tested during this study.

Indicator/Pathogen Correlations

One goal of this study was to assess the value of standard and non standard indicator groups for predicting the occurrence of pathogens or conversely, assuring the absence of pathogens. Since no viable parasites and only two virus isolates were detected, examining the occurrence of these agents relative to indicator populations was precluded. Coliphage densities varied with coliform populations suggesting that phage, as measured in this study, would not be a good surrogate for enteric viruses in treated sludges. The interelationships of the indicator groups themselves and their relationship to the occurrence of the potentially pathogenic bacteria can be analyzed.

Tables 31 and 32 show correlation matrices for the grouped data from all of the windrow composting site samples (IX-A-1 through IX-A-6) and the static pile samples (III-B-1, 2) respectively. As might be expected, the strongest correlation occurred between total coliform and fecal coliform (0.974 and 0.910 for the windrow and static pile sites, respectively. The fecal streptoccocci populations also correlated with the coliform groups ($r > 0.75$).

Due to the large number of samples, the critical r values were fairly low for the correlations, 0.126 for the windrow samples and 0.205 for the static pile sites. Therefore, at the 95% confidence level a correlation was detected any time the test r value was greater than the critical value. The correlation matrices show that many of the microbiological populations correlated with each other but that the strength of the correlations were often weak. Overall, population correlations were stronger at the windrow site than the static pile site. This may reflect the apparent regrowth phenomenon observed with the windrow products where most populations appeared to increase simultaneously.

The coliforms and fecal streptococci were the best indicators for the occurrence of salmonellae. Fecal coliforms, followed by total coliforms and fecal streptococci produced the strongest correlations with the windrow facility samples. At the static pile site, salmonellae correlated best with fecal streptococci, fecal coliform and total coliform in that order.

All of the data from both facilities were grouped to further examine the relationship between coliforms and fecal streptococci versus salmonellae. Scatter plots and regression analyses of these data are shown in Figures 23 through 25. Data points below the salmonellae detection limit are shown on the scatter plots (cutoff at -1 on y axis) but were not included in calculation of the regression line. It is reasonable to assume that these points would have followed a similar distribution pattern if the test procedures could have measured lower concentrations.

Although there is a great deal of scatter in the data, there is clearly a relationship between indicator concentration and salmonellae density. Using the derived regression equations, it can be predicted that salmonellae populations would be below the analytical detection limit (<0.2 MPN/g) when indicator concentrations were 240 MPN/g, 43 MPN/g and 73 MPN/g respectively for total coliform, fecal coliform, and fecal streptococci.

Currently there are no standards or guidelines that would designate an acceptable level of salmonellae. Compost or sludge products containing no detectable salmonellae when tested with acceptable analytical techniques performed by competent personnel would probably represent a conservative margin of safety given current knowledge about infective doses and the ubiquity of salmonellae in the environment.

Therefore, in addition to the standard linear correlations of the quantitative data, the ability of the coliforms and fecal streptococci to predict the occurrence of salmonellae in compost were examined from another approach. The indicator bacterial data were divided into log increment groups. Indicator values with a log mantissa greater than .699 were rounded up to the next higher log increment; values with a log mantissa less than .699 were rounded down. All of the data from both of the facilities were grouped in this manner. Then the probability of salmonellae being detected in a sample was determined for each group. The probability of salmonellae being detected at each increment of indicator bacteria was plotted and is shown in Figures 26-28. As can be seen, the concentration of indicator bacteria was very stongly related to the probability of salmonellae being detected. Linear regression lines were computed for these data points but the relationship is actually S shaped since the probability limits of 1 and 0 cannot be exceeded. A more sophisticated non linear analysis of these data could possibly be performed and would likely indicate that there would be some finite probability of detecting salmonellae when indicator desities were very low. Nevertheless, it was felt that the linear regression extrapolated to the zero probability level provided a reasonable estimate of the indicator concentrations that would be assoicated with a very low probability of salmonellae being detected. These values were: total coliform 240 MPN/g, fecal coliform 47 MPN/g and fecal streptococci 150 MPN/g. Examining the data used to construct this relationship revealed that no salmonellae isolations occurred when the indicator densities were below the extrapolated levels. Although the derived indicator concentrations do not guarantee the complete absence of salmonellae in compost, they would appear to provide a reasonably conservative level of assurance that salmonellae would not be detected using the analytical procedures employed during this study.

Interestingly, the two approaches to analyzing the data produced very similar results for the total and fecal coliform densities that would indicate no detectable salmonellae. The predicted fecal streptococci levels varied by a factor of 2 but that difference is not great considering the orders of magnitude spread of data.

TABLE 31 CORRELATION MATRIX OF MICROBIOLOGICAL PARAMETERS - WINDROW COMPOSTING SITES (IX-A-1 THROUGH IX-A-6)

						r VALUES						
		T_COLIF	F_COLIF	F_STREP	AER_PC	ANAER_PC	TOT_ENT	PHAGE	TOT_FUNG	THERM_FU	VERSIN	SALMON
		2	3	4	5	6	7	10	11	12	14	13
T_COLIF	2	1.000										
F_COLIF	3	0.974	1.000									
F_STREP	4	0.756	0.781	1.000								
AER_PC	5	0.672	0.662	0.616	1.000							
ANAER_PC	6	0.640	0.632	0.509	0.601	1.000						
TOT_ENT	7	0.660	0.640	0.566	0.676	0.550	1.000					
PHAGE	10	0.690	0.708	0.682	0.491	0.530	0.431	1.000				
TOT_FUNG	11	0.594	0.594	0.441	0.633	0.520	0.495	0.466	1.000			
THERM_FU	12	0.639	0.645	0.436	0.575	0.518	0.476	0.523	0.712	1.000		
VERSIN	14	0.301	0.299	0.171	0.153	0.254	0.287	0.233	0.208	0.232	1.000	
SALMON	13	0.648	0.669	0.576	0.399	0.427	0.445	0.570	0.431	0.453	0.271	1.000

CRITICAL r VALUE = 0.126 AT P=0.05; 0.164 at P=0.001

TABLE 32 CORRELATION MATRIX OF MICROBIOLOGICAL PARAMETERS - STATIC PILE SITES (III-B-1,2)

						r VALUES						
		T_COLIF	F_COLIF	F_STREP	AER_PC	ANAER_PC	TOT_ENT	PHAGE	TOT_FUNG	THERM_FU	VERSIN	SALMON
		2	3	4	5	6	7	10	11	12	14	13
T_COLIF	2	1.000										
F_COLIF	3	0.910	1.000									
F_STREP	4	0.771	0.819	1.000								
AER_PC	5	0.708	0.681	0.672	1.000							
ANAER_PC	6	0.547	0.531	0.564	0.661	1.000						
TOT_ENT	7	0.765	0.688	0.652	0.893	0.594	1.000					
PHAGE	10	0.675	0.685	0.636	0.559	0.388	0.569	1.000				
TOT_FUNG	11	0.204	0.128	-0.124	0.189	-0.065	0.255	0.060	1.000			
THERM_FU	12	0.229	0.180	0.034	0.180	0.080	0.218	0.142	0.602	1.000		
VERSIN	14	0.366	0.303	0.282	0.468	0.363	0.517	0.474	0.086	0.021	1.000	
SALMON	13	0.550	0.604	0.640	0.335	0.418	0.321	0.439	-0.193	0.040	-0.097	1.000

CRITICAL r VALUE = 0.205 AT P=0.05; 0.267 at P=0.001

Figure 23

Total Coliform vs Salmonella - Scatter Plot

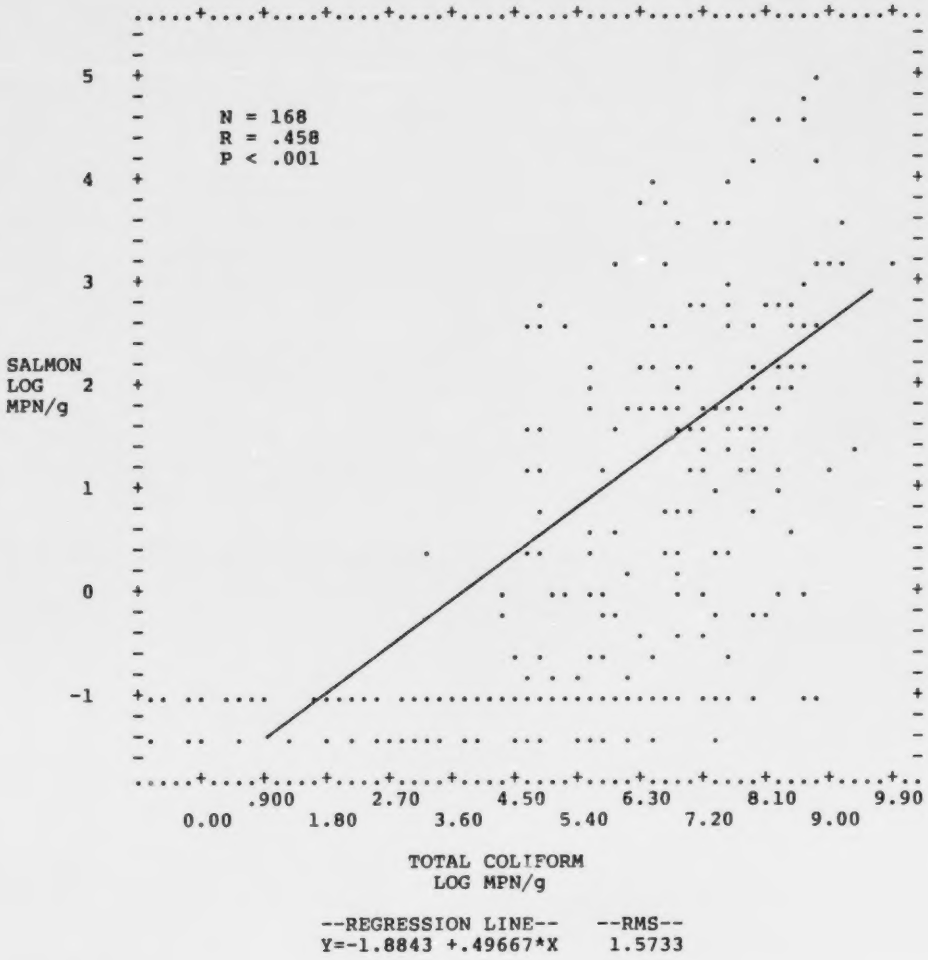
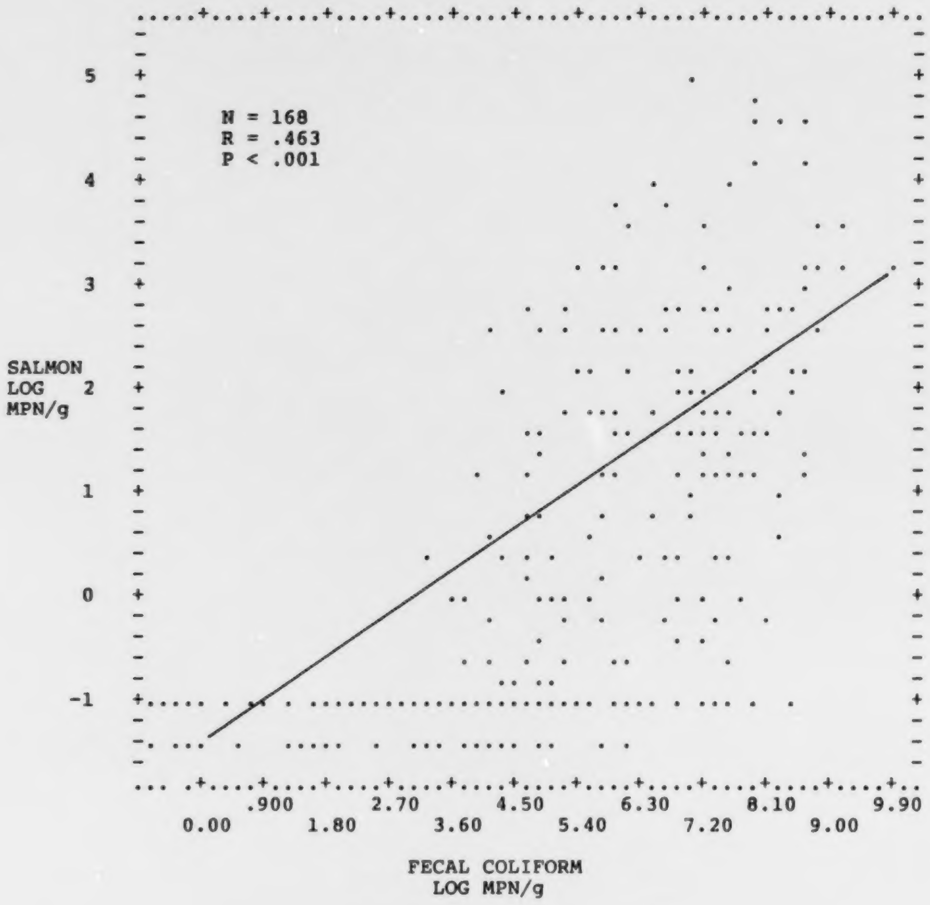


Figure 24

Fecal Coliform vs Salmonella - Scatter Plot



--REGRESSION LINE-- --RMS--
Y=-1.4604 +.46383*X 1.5633

Figure 25

Fecal Streptococci vs Salmonella - Scatter Plot

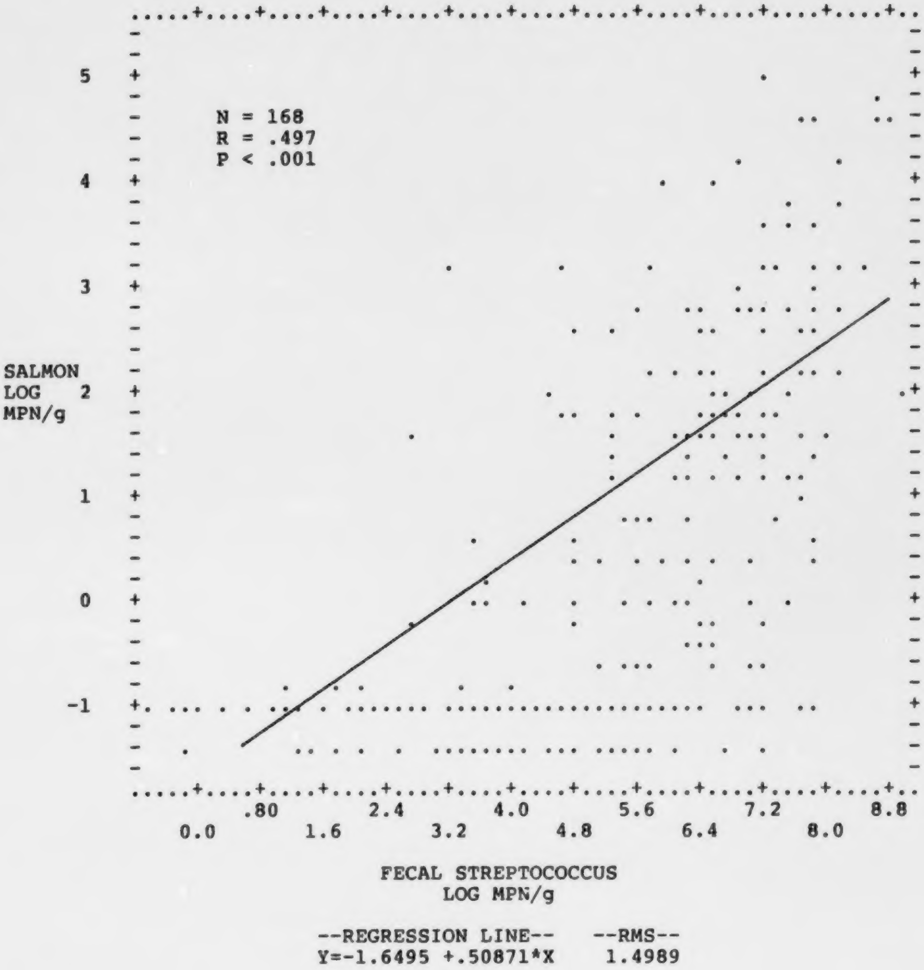


FIGURE 26 TOTAL COLIFORM VS SALMONELLAE PROBABILITY-
ALL DATA INCLUDED

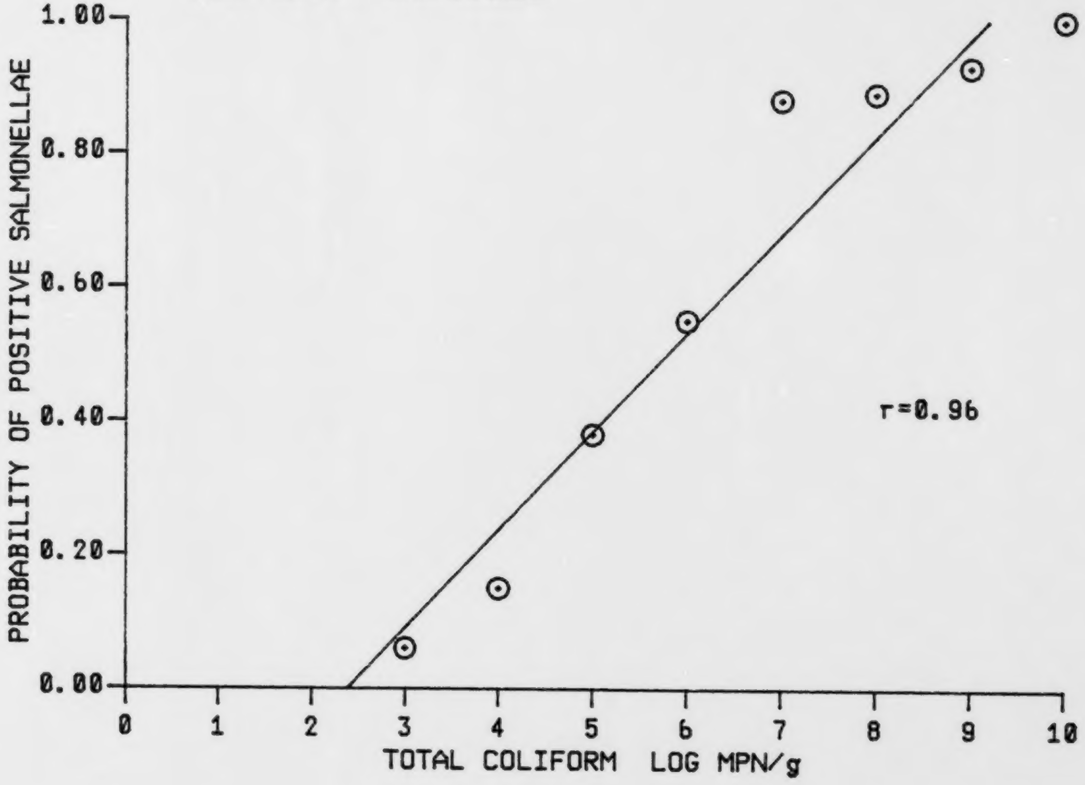


FIGURE 27 FECAL COLIFORM VS SALMONELLAE PROBABILITY- ALL DATA INCLUDED

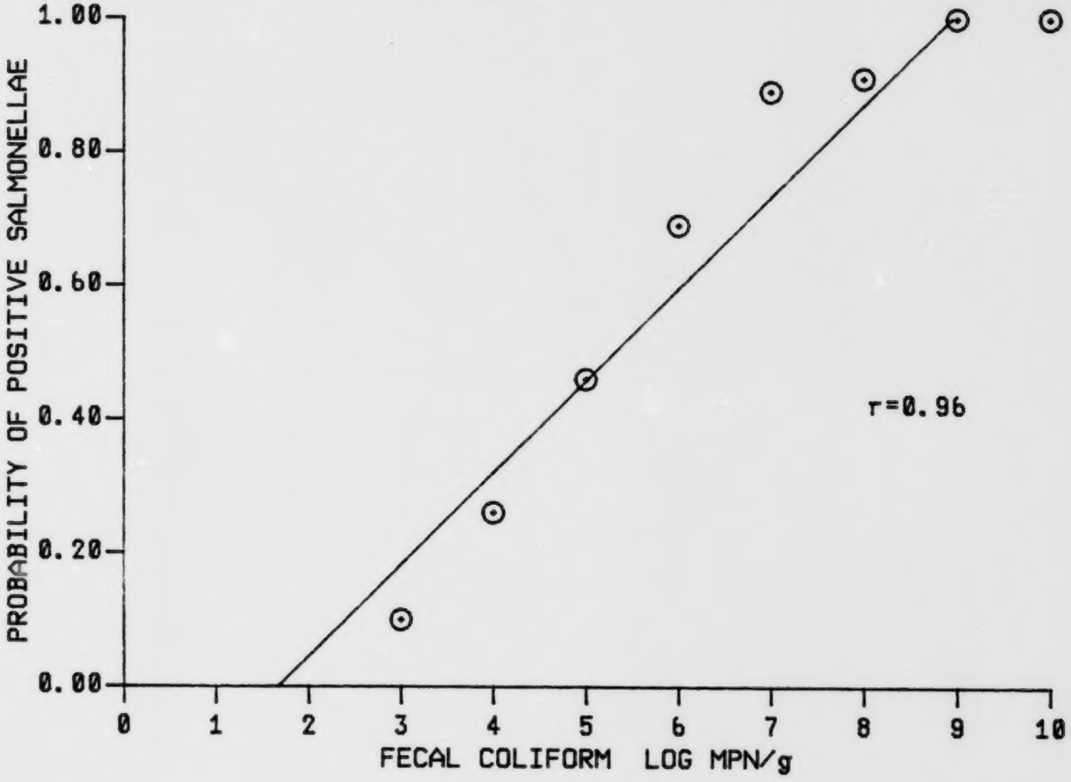
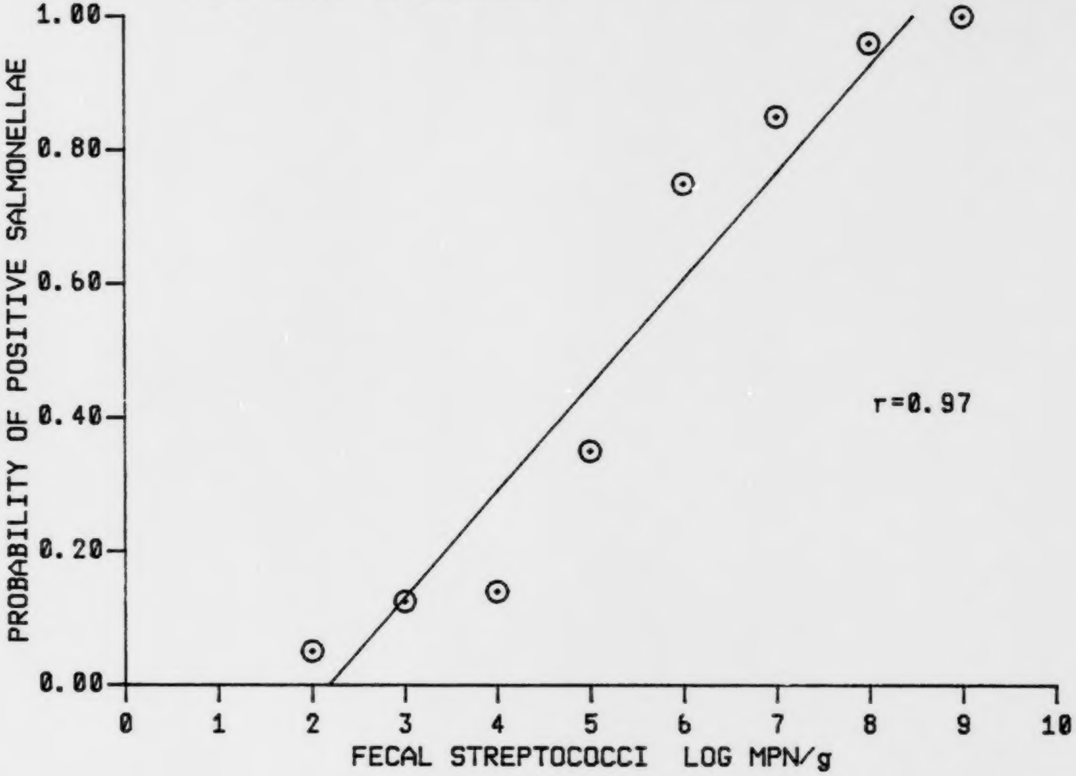


FIGURE 28 FECAL STREPTOCOCCI VS SALMONELLAE PROBABILITY- ALL DATA INCLUDED



Yersinia populations did not correlate as well as salmonellae did with the standard indicators. Although a statistically significant correlation did exist between *Yersinia* occurrences and all other groups, the strengths of the correlations were relatively weak. Only scattered isolations of *Yersinia* occurred at the windrow sites so the correlation coefficients are of little significance. Substantial numbers of *Yersinia* were detected at the static pile sites but no strong correlations developed; *Yersinia* populations correlated best with the total enteric plate count. The relatively poor correlations are probably the result of the seasonality of the *Yersinia* data which was not generally reflected with the other organisms.

In summary, there was a strong relationship between the densities of standard fecal indicator bacteria and the occurrence of salmonellae implying that the indicator bacteria may have value for process control monitoring. The actual value of bacterial monitoring may be questionable if salmonellae are capable of repopulating under certain conditions following the composting process. In this case point of sampling would be critical to assessing the quality of treated sludges utilized in D & M programs. Monitoring would need to be as close to the user as possible and include amended products where applicable.

As mentioned in the earlier dicussion about salmonellae, a voluntary coliform monitoring program was instituted at the windrow facility. In addition to meeting minimum recommended time and temperature requirements (40 CFR 257.4), compost is not released to the commercial producer until total coliforms have been reduced to a median of 10 MPN/gdw, based on previously published recommendations (Haug 1980). Continued monitoring of the commercial products (unpublished data) indicates that the levels of salmonellae have been substantially reduced in the bagged products since instituting the field monitoring program.

It is not entirely clear why salmonellae levels declined in the bagged products after instituting the coliform monitoring. Few salmonellae were detected in the final compost (IX-A-1 & IX-A-2) prior to initiating the coliform monitoring program. Achieving the low coliform level sometimes requires longer composting time than dictated by time/temperature requirements alone. It may be that the low coliform level reflects a degree of stabilization that limits the potential for salmonellae regrowth. If this is the case, it is possible that other measures of stabilization may also suffice. It should also be noted that a small number of windrows never met the 10 MPN/g median coliform level even with extended composting time (additional 3 to 4 weeks). These windrows were tested for salmonellae and released if negative. Although this study indentified a correlation between bacteria indicator concentrations and salmonellae levels, the critical factors determining whether or not salmonellae repopulation can occur have not been identified. Bacterial monitoring may indicate the potential for salmonellae being present and may also serve as an indicator of regrowth potential, but better knowledge of the mechanism involved with the survival and regrowth of enteric bacteria in compost is the key to effectively controlling this phenomenon.

MICROBIOLOGICAL RESULTS - BIMONTHLY SITES

The final sludge product produced at twenty-four treatment facilities was sampled every other month for one year. The sampling sites were described in detail in Section 4. Facilities sampled were well distributed around the continental U.S. and included composting facilities, drying bed operations and heat treatment processes. The treatment plants and basic processes were summarized in Tables 2 and 4.

The basic process groupings represent generalized descriptions. Other treatment variables combined with climatic variations resulted in not having any of the sampling sites represent truly identical treatment processes.

Indicator Organisms

Individual data for each of the twenty-four facilities is tabulated in Appendix C. Table 33 lists the mean values for the indicator groups at each site. It was not feasible to compare sites individually because with twenty-four sites there were 276 pairwise comparisons possible. No single site was highest or lowest for all organisms. The lowest mean coliform densities were measured at III-J-1, an aerated windrow site. Site IX-D-1, a drying bed facility had the lowest fecal steptococci counts. Site IV-I-1, the heat drying site, had the lowest aerobic and anaerobic plate counts, total enteric plate count and fungal counts. The lowest coliphage densities occurred jointly at IV-I-1 and IX-D-3. The highest microorganism levels occurred at two sites. The greatest mean densities of fecal streptococci and aerobic and anaerobic plate count bacteria were measured at V-K-1, the thermally conditioned sludge. Site IV-B-1, a static pile composting facility, produced the highest concentrations of coliforms, total enterics, fungi and coliphage.

After tabulating the geometric means for each sampling site, the data were grouped by treatment process. The means for products produced by each are shown in Table 34. No one process was lowest or highest for all of the microorganism groups tested. In order to provide some overall rating, the nine processes were ranked for microorganism density for each test, with 1 representing the lowest density of microorganisms and 9 being the highest. These rankings are listed in Table 35. The position numbers were then averaged for each process. The numbers represent only the average number of times a process yielded the lowest, highest or intermediate concentration of the indicator organisms listed in Table 34. In this manner, the processes were arranged and are listed in Table 36 from lowest to highest combined concentration of organisms.

TABLE 33 GEOMETRIC MEAN CONCENTRATIONS OF INDICATOR GROUPS AT BIMONTHLY SITES (n=6 for each site)

SITE	LOG MPN/g			LOG CFU/g					LOG PFU/g
	TOTAL COLIFORM	FECAL COLIFORM	FECAL STREP	PLATE COUNT	ANEROBIC PLATE COUNT	TOTAL ENTERIC	TOTAL FUNGI	THERM FUNGI	COLI-PHAGE
I-B-1	3.309	2.215	1.897	8.012	7.347	6.968	3.322	2.614	1.160
II-C-1	1.674	1.341	2.353	7.221	6.878	4.884	1.997	2.262	1.457
III-B-3	2.076	0.348	2.782	8.647	6.826	7.111	2.332	2.062	0.938
III-B-4	5.448	4.575	5.851	9.343	8.164	7.993	3.670	3.350	1.694
III-J-1	0.628	0.145	2.712	8.381	6.267	6.611	1.778	1.556	0.967
IV-B-1	8.119	7.306	5.744	9.699	8.703	9.107	5.755	6.256	3.310
IV-D-1	2.577	1.460	2.197	7.853	6.269	6.274	3.292	2.946	0.762
IV-F-1	7.122	6.116	4.908	9.030	7.387	7.909	4.362	2.870	1.853
IV-I-1	1.254	0.658	3.326	5.715	5.531	2.084	0.848	0.701	0.749
V-B-1	4.032	3.159	2.169	8.496	7.112	6.854	4.255	4.041	1.384
V-K-1	5.299	4.234	7.092	9.879	8.814	8.285	1.886	0.890	1.392
VI-D-1	3.321	1.145	1.956	7.611	6.760	6.060	3.900	3.149	0.878
VII-D-1	1.284	1.067	1.168	6.694	5.755	3.342	2.448	2.765	1.191
VII-A-2	1.982	0.697	1.812	8.216	6.684	7.028	2.691	2.581	0.992
VIII-D-1	6.261	5.476	4.709	9.568	8.040	8.514	3.652	3.186	3.008
VIII-F-1	3.758	0.426	3.826	8.476	6.818	7.559	4.012	1.811	1.640
VIII-H-1	3.745	1.921	1.887	8.389	7.390	7.603	3.477	3.456	1.110
VIII-J-1	2.470	1.828	2.481	8.235	6.208	6.481	2.900	2.302	1.141
IX-A-10	3.505	1.893	2.980	8.648	8.158	7.888	1.691	1.663	1.207
IX-B-1	7.099	6.074	5.275	9.442	8.296	8.366	5.566	5.713	2.070
IX-D-1	3.429	0.851	0.994	8.089	6.314	7.837	1.437	0.693	1.178
IX-D-2	3.657	1.860	1.768	8.133	6.706	6.232	4.128	2.335	1.246
IX-D-3	2.945	1.677	1.252	8.139	6.796	6.074	4.346	4.354	0.749
X-C-1	5.210	3.229	3.947	8.919	7.905	8.173	2.292	2.344	1.416

TABLE 34 GEOMETRIC MEAN CONCENTRATION OF INDICATOR ORGANISMS GROUPED BY PROCESS

	LOG MPN/g			LOG CFU/g					LOG PFU/g
PROCESS	TOTAL COLIFORM	FECAL COLIFORM	FECAL STREP	PLATE COUNT	ANAEROBIC PLATE COUNT	TOTAL ENTERIC	TOTAL FUNGI	THERM FUNGI	COLI-PHAGE
WINDROW COMPOSTING	2.744	1.295	2.396	8.432	7.421	7.458	2.191	2.122	1.100
AERATED WINDROW	1.549	0.987	2.596	8.308	6.238	6.546	2.339	1.929	1.054
STATIC PILE	5.013	3.946	3.953	8.940	7.742	7.733	4.150	4.006	1.759
IN-VESSEL	3.442	2.285	3.150	8.070	7.392	6.529	2.145	2.307	1.437
AN DIG AIR DRY	3.354	1.934	2.006	8.012	6.663	6.333	3.336	2.776	1.287
AER DIG - AIR DRY	5.440	3.271	4.367	8.753	7.102	7.734	4.171	2.341	1.746
HEAT DRY	1.254	0.658	3.326	5.715	5.531	2.084	0.848	0.701	0.749
THERMAL COND	5.299	4.234	7.092	9.879	8.814	8.285	1.886	0.890	1.392
PROPRIETARY	3.745	1.921	1.887	8.389	7.390	7.603	3.477	3.456	1.110

TABLE 35 GEOMETRIC MEAN CONCENTRATION OF INDICATOR ORGANISMS GROUPED AND RANKED

	INDEX								
PROCESS	TOTAL COLIFORM	FECAL COLIFORM	FECAL STREP	PLATE COUNT	ANAEROBIC PLATE COUNT	TOTAL ENTERIC	TOTAL FUNGI	THERM FUNGI	COLI-PHAGE
WINDROW COMPOSTING	3	3	3	6	7	5	4	4	3
AERATED WINDROW	2	2	4	4	2	4	5	3	2
STATIC PILE	7	8	7	8	8	7	8	9	9
IN-VESSEL	5	6	5	3	6	3	3	5	7
AN DIG AIR DRY	4	4	2	2	3	2	6	7	5
AER DIG - AIR DRY	9	7	8	7	4	8	9	6	8
HEAT DRY	1	1	6	1	1	1	1	1	1
THERMAL COND	8	9	9	9	9	9	2	2	6
PROPRIETARY	6	5	1	5	5	6	7	8	4

Table 36. Processes Ranked From Lowest to Highest Indicator Microorganism Density

Process	Index
Heat Drying	1.6
Aerated Windrow Composting	3.1
Anaerobic Digestion - Air drying	4.0
Windrow Composting	4.2
In-vessel Composting	4.8
Proprietary Composting	5.1
Thermal Conditioning (Dewatered)	7.0
Aerobic Digestion - Air drying	7.3
Static Pile Composting	7.9

The products were ranked by process for illustrative purposes only. The significance of these rankings is unclear. The natural assumption would be that lower concentrations of indicator and background microogansisms would be desirable. As previously mentioned, Hussong et al (1985) suggested the opposite was true and that high levels of indigenous microflora, including coliforms, would suppress salmonellae; however, results from this study appear to differ from those findings.

Perhaps the most surprising aspect of these data was how well the anaerobically digested, air dried sludges ranked compared to the composted sludges. Only the heat dried sludge and aerated windrow facility samples contained lower overall concentrations of indicator organisms.

On the other hand, the relatively poor ranking of the static pile products should not be viewed as an indictment of static pile systems, per se. The composts included in the static pile ranking ranged from products that contained very low densities of miroorganisms (III-B-3) to those whose products contained among the highest concentrations of microorganisms (IV-B-1 and IX-B-1). The full range of data from these sites can be examined by looking at all "B" designated sites in Table 33 and Appendix C. Investigation of the reasons for these differences may provide a better understanding of operation variables.

The fungi isolated at the bimonthly sites were similar to those detected at the weekly sites. The only fungus detected of any potential health significance was *Aspergillus fumigatus*. The average concentrations of *A. fumigatus* at each site are shown in Table 37 and grouped by process in Table 38. The static pile composts contained the greatest concentrations of *A. fumigatus.*

Table 37 Occurrence of *Aspergillus fumigatus* at Bi-Monthly Sampling Sites (Geometric Means)

Site	% Positive	Mean CFU/g	Site	% Positive	Mean CFU/g	Site	% Positive	Mean CFU/g
I-B-1	83	470	IV-I-1	33	3	VIII-H-1	83	1500
II-C-1	17	5	V-B-1	100	10,000	VIII-J-1	67	120
III-B-3	50	21	V-K-1	17	2	IX-A-10	50	15
III-B-4	67	140	VI-D-1	100	2,000	IX-B-1	100	380,000
III-J-1	33	6	VII-D-1	50	250	IX-D-1	17	4
IV-B-1	100	1,300,000	VII-A-2	83	280	IX-D-2	50	10
IV-D-1	83	830	VIII-D-1	83	410	IX-D-3	83	15,000
IV-F-1	33	8	VIII-F-1	33	10	X-C-1	50	40

Table 38 Occurrence of *Aspergillus fumigatus* Grouped by Treatment Process

Process	CFU/g	
	Geometric Mean	Range
Heat Treated	3	<10 - 40
Aerobic Dig/DB	9	<10 - 2,500
In-Vessel Composting	14	<10 - 22,000
Aerated Windrow	27	<10 - 4,700
Windrow	65	<10 - 29,000
Anaerobic Dig/DB	270	<10 - 32,000
Prop. Compost	1500	<10 - 21,000
Static Pile	4400	<10 - 18,000,000

Pathogens

Salmonellae and *Yersinia* were randomly isolated from a relatively small number of samples from the bimonthly sites. A total of 144 samples (6 from each site) were collected for this part of the project. Salmonellae were detected in 27 samples and *Yersinia* were isolated in 15. Samples containing these bacteria are listed in Tables 39 and 40.

Table 39. Salmonella Positive Samples - Bimonthly Sites

Samples Containing Salmonellae	No. of Positive Samples(N=6)	Concentration(s) MPN/g
II - C - 1	1	810
III - B - 4	1	0.8
IV - B - 1	3	0.8; 170; 370,000
IV - F - 1	2	71; 2,200
IV - I - 1	1	0.4
V - K - 1	5	3.1; 3.8; 18; 24; 110
VIII - D - 1	4	1; 2; 64; 390
VIII - H - 1	1	1
IX - B - 1	1	0.6
IX - D - 1	1	140
IX - D - 2	2	0.1; 500
IX - D - 3	4	0.1; 2; 17; 48
X - C - 1	1	0.2

Thirteen of the twenty-four facilities that were sampled bimonthly had one or more samples with detectable salmonellae. Salmonellae were isolated from 50% or more of the samples at four of the sites. Two of these sites were drying bed plants, one was a thermal conditioning process and one was a static pile composting operation. Salmonellae densities in these samples ranged from 0.1 to 370,000 MPN/g. The data indicate that the occurrence of salmonellae observed at the weekly sites did not necessarily represent isolated situations. Detectable levels of salmonellae occurred in roughly 20% of the bimonthly samples but in most cases the densities were low.

Table 40. *Yersinia* Positive Samples - Bimonthly Sites

Samples Containing *Yersinia*	No. of Positive Samples(N=6)	Concentration(s) MPN/g
I - B - 1	2	0.2; 0.6
III - B - 4	1	0.4
IV - B - 1	2	1; 4200
IV - I - 1	1	0;1
V - B - 1	1	100
V - K - 1	1	1
VII - A - 2	1	2.7
VIII - D - 1	2	0.5; 3.9
VIII - F - 1	1	1
IX - B - 1	2	0.4; 0.6
X - C - 1	1	52

The *Yersinia* positive samples mostly contained very low concentrations of yersiniae. In all but one case, the *Yersinia* isolations occurred during the period from December through May, providing further evidence for the seasonal occurrence of *Yersinia* as hypothesized earlier.

As previously described, many of the *Yersinia* isolates were sent to the New York State Department of Health for detailed identification. Results of these tests are shown in Table 41.

Table 41 Identification of *Yersinia* Isolates from the Bi-Monthly Sites

SITE	Sample Date	Isolate No.	Identification	Serotype	Pathogenicity Test
I-B-1	8-18-86	1	*Y.enterocolitica*	0:8	Neg
	12-22-86	1	*Y.enterocolitica*	0:8, 14	Neg
		2	*Y.frederiksenii*	0:29	NT(b)
III-B-4	2-23-87	1	*Y.frederiksenii*	0:16, 29	Neg
IV-B-1	2-09-87	1	*Y.enterocolitica*	NG(a)	Neg
IV-I-1	2-25-87	1	*Y.intermedia*	0:12	Neg
V-B-1	2-9-87	1 - 4	*Y.enterocolitica*	NG	Neg(c)
V-K-1	12-8-86	1	*Y.intermedia*	0:4, 16	Neg
VIII-D-1	5-5-86	1	*Y.enterocolitica*	NG	Neg
		2	*Y.frederiksenii*	NG	NT
IX-B-1	1-26-87	1	*Y.frederiksenii*	0:16, 29	Neg
X-C-1	3-9-87	1 - 5	*Y.kristensenii*	0:16, 29	Neg(d)
		6 - 14	*Y.kristensenii*	NG	NT

(a) NG - Non Groupable
(b) NT - Not Tested
(c) 1 of 4 isolates tested
(d) 1 of 5 isolates tested

A number of the *Yersinia* isolates were also tested for pathogenicity. The 0:8 serotype detected at site I-B-1 is the most common pathogenic sertoype occurring in the U.S.; however, none of the isolates tested, including the 0:8 serotype were positive in the pathogenicity tests. Environmental yersiniae isolates generally have not been found to test positive in pathogenicity tests regardless of their serogroups (M. Shayegani, personal communication). The factors mediating pathogenicity in the *Yersinia* are not thoroughly understood. It is not known if potentially pathogenic *Yersinia*, such as the 0:8 serotype can revert to the pathogenic form.

Toxigenic *E. coli* were detected in four samples, one each from III-B-4, IV-D-1, IV-F-1 and IX-B-1. The previous discussion about toxigenic *E. coli* colonies suggests the densities of toxigenic strains may be higher than indicated by the data shown in the tables in Appendix C.

As at the weekly sites, no *Campylobacter* were isolated. Available evidence strongly suggests that campylobacters would not survive in either composting systems or drying beds.

Intact helminth ova were detected in at least one or more samples from every facility except IX-D-2. The predominant ova detected were *Trichuris*, *Ascaris* and *Toxocara*. One potentially viable *Trichuris* ovum was observed in the May 12, 1986 sample from site VIII-F-1. The ovum contained a fully developed embryo. The embryo was not observed to move within the ovum and movement could not be induced with intense light from the microscope illuminator.

The sludge treatment process employed at site VIII-F-1 was aerobic digestion followed by air drying and storage. It is possible that conditions during aerobic digestion were suitable for embryonation to occur but that the embryo died during the ensuing two year period of drying and storage. Embryo movement would have confirmed viability but since no movement could be induced, the condition of the developed ovum was uncertain.

No other detected ova showed any signs of development or indications of viability after incubation. Most of the *Trichuris* ova detected from the bimonthly samples were also outside the size range for *Trichuris trichiura* again suggesting non-human orgin. Also, as was the case for the weekly sites, no protozoan cysts were observed in any of the bimonthly samples.

The previous discussion about viruses is applicable to the bimonthly sites. A polio 1 virus was isolated from one sample (III-J-1, 5-29-86) but it was almost assuredly a laboratory contaminant. Enteric viruses were not detected in any other bimonthly sample. Given available analytical technology, there would appear to be little if any concern associated with enteric viruses in properly treated sludges.

The small number of samples from each site and large variation in the data preclude meaningful statistical analysis of data from the bimonthly sites. The results did reveal that most of the sludge products examined contained few detectable enteric pathogens but that bacterial pathogens may sometimes be a concern.

The data also suggest that anaerobic digestion and air drying may be an acceptable low cost sludge treatment process for eliminating microbiological health hazards. Digestion and drying parameters and storage time need to be clearly defined to qualify air drying as an acceptable process. Although microbial levels in dried sludges compared favorably with composted sludges examined during this study, the dried sludges have not received the additional stabilization that occurs during composting. The potential for bacterial regrowth in remoistened air dried sludges is unknown.

REFERENCES

1. Adams, M. H. 1959. Bacteriophages. Interscience, New York, N.Y.

2. Akin, E. W., W. Jakubowski, J. B. Lucas, and H. R. Pahren 1977. Health hazards associated with wastewater effluents and sludge. In: Proceedings of the Conference on Risk Assessment and Health Effects of Land Application of Municipal Wastewater Sludges (B. P. Sagik and C. A. Sorber, eds.) pp. 9-25, The University of Texas at San Antonio, San Antonio, TX.

3. American Public Health Association, American Water Works Assoc. Water Pollution Control Federation. 1985. Standard Methods for Examination of Water and Wastewater, 16th ed. American Public Health Association, Washington, D.C.

4. American Public Health Association. 1970. Control of Communicable Diseases in Man, 11th ed. (A. S. Benenson, Ed.), A.P.H.A., New York.

5. Anjello, L. 1958. Soil as a natural reservoir for human pathogenic fungi. Science 123:876-879.

6. Barnett, H. L. and B. B. Hunter. 1972. Illustrated Genera of Imperfect Fungi, third edition. Burgess Publishing Company, Minneapolis, Minnesota, pp. 1-239.

7. Bercovier, H., J. Brault, S. Cohen, R. Melis, T. Lambert, and H. H. Mollaret. 1984. A new isolation medium for the recovery of Yersinia enterocolitica from environmental sources. Current Microbiology, Vol. 10. pp. 121-124.

8. Bergey's Manual of Systematic Bacteriology, Vol. 1. 1984. N. R. Krieg, ed., Williams and Wilkins, Baltimore.

9. Beuchat, L. R. 1985. Efficacy of media and methods for detecting and enumerating Campylobacter jejuni in refrigerated chicken meat. Appl. Environ. Microbiol 50:934-939.

10. Blaser, M. J., I. D. Berkowitz, F. M. LaForce, J. Cravens, L. B. Reller, W. Wang. 1979. Campylobacter enteritis: clinical and epidemiologic features. Ann. Intern. Med. 91:179-85.

11. Blaser, M. J., H. L. Hardesty, B. Powers, W. L. Wang 1980a. Survival of _Campylobacter jejuni_ in biological milieus. Journal of Clinical Microbiology _11_:309-313.

12. Blaser, M. J., F. M. LaForce, N. A. Wilson, W. L. Wang. 1980b. Reservoirs for human campylobacteriosis. Journal of Infectious Disease. _141_:665-669.

13. Blaser, M. J. and L. B. Reller. 1981. _Campylobacter_ enteritis. New England Journal of Medicine, _305_:1444-1451.

14. Boik, R. J. 1979. Interactions, partial interactions and interaction contrasts in the analysis of variance. Psychological Bulletin, _86_:1084-1089.

15. Brandon, J. R. 1978. Parasites in sludge/soil systems. Sandia Laboratories, Albuquerque, N.M., Available from NTIS, Springfield, VA.

16. Brandon, J. R., W. D. Burge, and N. E. Enkiri. 1977. Inactivation by ionizing radiation of _Salmonella enteritidis_ serotype montevideo growth in composted sewage sludge. Appl. Environ. Microbiol. _33_:1011-1012.

17. Brown, Harold W. 1975. Basic clinical parasitology, fourth edition. (D. L. Belding, ed.) Appleton-Century-Crofts. New York. pp. 112-116.

18. Burrows, W. 1968. Textbook of Microbiology - The Pathogenic Microorganisms. p. 708. W.B. Saunders Co., Philadelphia.

19. Craun, G. F. 1979. Waterborne disease - A status report emphasizing outbreaks in groundwater systems. Groundwater _17_:183.

20. D'Aoust, J. Y. and H. Pivnick. 1976. Small infectious doses of _Salmonella_. Lancet, 1, 866.

21. Doyle, Michael, P., and D. J. Roman. 1982. Recovery of _Campylobacter coli_ from inoculated foods by selective enrichment. Appl. Environ. Microbiol. _43_:1343-1353.

22. Doyle, Michael, P., and D. J. Roman. 1982. Sensitivity of _Campylobacter jejuni_ to drying. Journal of Food Protection. _45_:507-510.

23. Dudley, D. J., M. N. Guentzel, M. J. Ibarra, B. E. Moore and B. P. Sagik. 1980. Enumeration of potentially pathogenic bacteria from sewage sludges. Appl. Environ. Microbiol. _39_:118-126.

24. EPA. 1978. Microbiological Methods for Monitoring the Environment - Water and Wastes. R. Bordner and J. Winter, eds. EPA-600/8-78-017.

25. Farrell, J. B. 1986. Risk of infectious disease from use of sludge on land and methods to reduce these risks. (PB86-166378). Available from NTIS, Springfield, VA 22161

26. Feachem, Richard G., D. J. Bradley, H. Garelick, and D. D. Mara. 1983. Sanitation and Disease: Health Aspects of Excreta and Wastewater Management. World Bank Studies in Water Supply and Sanitation 3. John Wiley and Sons, New York, N.Y.

27. Geldreich, E. 1972. Waterborne pathogens. In: Water Pollution Microbiology (R. Mitchell ed.) John Wiley & Sons, Inc. New York. pp. 207-241.

28. Gerba, C. P. 1983. Pathogens. In: Utilization of Municipal Wastewater and Sludge on Land (A. L. Page, T. L. Gleason, J. E. Smith, I. K. Iskander, and L. E. Sommers, eds.), pp. 147-187, University of California, Riverside, CA.

29. Glass, J. S., R. J. Van Sluis and W. A. Yanko. 1978. Practical method for detecting poliovirus in anaerobic digester sludge. Appl. and Environ. Microbiol. 35:983-985.

30. Gleit, A. 1985. Estimation for small normal data sets with detection limits. Environ. Sci. Technol. 19:1201-1206.

31. Goldschmidt, M. C. and DuPont, H. L. 1976. Enteropathogenic Escherichia coli: Lack of correlation of serotype with pathogenicity. The Journal of Infectious Diseases. 133(2):153-156

32. Goldstein, N. 1983. Marketing composted sludge. Biocycle, Nov-Dec., p. 29-31.

33. Goyal, S. M., S. A. Schaub, F. M. Wellings, D. Berman, J. S. Glass, C. J. Hurst, D. A. Brashear, C. A. Sorber, B. E. Moore, G. Bitton, P. H. Gibbs, and S. R. Farrah. 1984. Round robin investigation of methods for recovering human enteric viruses from sludge. Appl. and Environ. Microbiol. 48:531-538.

34. Haug, R.R. 1980. Compost Engineering, Principles and Practice. Ann Arbor Science Publisher Co., Inc., Ann Arbor, MI.

35. Hay, J. C. 1986. Compost Salmonellae Study, Phase I, II, and III. Agency Report: County Sanitation Districts of Los Angeles County, Carson, CA.

36. Hays, B. D. 1977. Potential for parasitic disease transmission with land application of sewage plant effluents and sludges. Water Research. *11*:583-595.

37. Head, Carol B., Deborah A. Whitty, and Samual Ratnam. 1982. Comparative study of selective media for recovery of *Yersinia enterocolitica*. Journal of Clinical Microbiology. *Vol. 16, No. 4*. p. 615-621.

38. Heisick, Judy. 1985. Comparison of enrichment broths for isolation of *Campylobacter jejuni*. Applied and Environmental Microbiology. *50*:1313-1314.

39. Hunt, J. M., D. W. Francis, J. T. Peeler, and J. Lovett. 1985. Comparison of methods for isolating *Campylobacter jejuni* from raw milk. Applied and Environmental Microbiology. *50*:535-536.

40. Hussong, David, W. D. Burge, and N. K. Enkiri. 1985. Occurrence, growth, and suppression of salmonellae in composted sewage sludge. Applied and Environmental Microbiology. *50(4)*:887-893.

41. Kaneshiro, Edna S., and Gerald Stern. 1985. Survival of parasite eggs in stored sludge. (PB86-137148). Available from NTIS, Springfield, VA 22161.

42. Kott, Y. 1966. Estimation of low numbers of *Escherichia coli* bacteriophage by use of the most probable number method. Appl. Microbiol. *14(2)*:141-144.

43. Kowal, N. E. 1983. An overview of public health effects. In: Utilization of Municipal Wastewater and Sludge on Land (A. L. Page, T. L. Gleason, J. E. Smith, I. K. Iskander, and L. E. Sommers, ed.), pp. 329-394, University of California, Riverside, CA.

44. Langeland, Gunnar. 1983. *Yersinia enterocolitica* and *Yersinia enterocolitica*-like bacteria in drinking water and sewage sludge. Acta path. microbiol. immunol. scand. *91*:179-185.

45. Lennette, Edwin H., E. H. Spaulding, J. P. Truant. 1974. Manual of Clinical Microbiology, Second Edition. American Society for Microbiology, Washington, D.C. pp. 291-294.

46. Levine, N.D. 1980. Nematode Parasites of Domestic Animals and of Man. Burgess Publishing Company. Minneapolis, MN.

47. Lim, K. A. and Benyesh-Melnick, M. 1969. Typing of viruses by combinations of antiserum pools. Application to typing of enteroviruses (coxsackie and ECHO). J. Immunology. *84*.309-317.

48. Lipson, A. 1976. Infecting dose of *Salmonella*. Lancet, *1*:969.

49. Mentznig, L. O. 1981. Waterborne outbreak of Campylobacter enteritis in central Sweden. Lancet. ii:352-254.

50. Metro. 1983. Metro sludge quality monitoring report and literature review. Metro Water Quality Division. Seattle, WA.

51. Miller, R. G. 1981. Simultaneous statistical inference. Springer-Verlag, New York.

52. Milner, P. D., P. B. Marsh, R. B. Snowden and J. F. Parr. 1977. Occurrence of Aspergillus fumigatus during composting of sewage sludge. Appl. Environ. Microbiol. 34:765-772.

53. O'Donnell, Cathlene J., K. B. Meyer, J. V. Jones, T. Benton, E. S. Kaneshiro, J. S. Nichols, and F. W. Schaefer III. 1984. Survival of parasite eggs upon storage in sludge. Applied and Environmental Microbiology. 48:618-625.

54. Oosterom, J., M. J. G. M. Vereijken, G. B. Engels. 1981. Campylobacter isolation. The Veterinary Quarterly. 3:104

55. Ottolenghi, Abramo C., and Vincent V. Hamparian. 1987. Multiyear study of sludge application to farmland: prevalence of bacterial enteric pathogens and antibody status of farm families. Applied and Environmental Microbiology. 53(5):1118-1124.

56. Page, A. L., T. L. Gleason, J. E. Smith, I. K. Iskandar and L. E. Sommers. 1983. Proceedings of the 1983 workshop on utilization of municipal wastewater and sludge on land. University of California, Riverside, CA.

57. Payment, Pierre, and Michel Trudel. 1985. Immunoperoxidase method with human immune serum globulin for broad-spectrum detection of cultivable human enteric viruses: application to enumeration of cultivable viruses in environmental samples. Applied and Environmental Microbiology. 50(5):1308.

58. Raper, K. B. and D. I. Fennel. 1965. The Genus Aspergillus, Robert E. Krieger Publishing Co., Malabar, FL., pp. 1-686.

59. Reimers, R. S., M. D. Little, A. J. Englande, D. B. Leftwich, D. D. Bowman, and R. F. Wilkinson. 1981. Parasites in southern sludges and disinfection by standard sludge treatment. Tulane University, New Orleans, LA. Available from NTIS, Springfield, VA.

60. Rogol, M., B. Shpak, D. Rothman, and I. Sechter. 1985. Enrichment medium for isolation of Campylobacter jejuni - Campylobacter coli. Applied. Environ. Microbiol. 50:125-126.

61. Rosef, Olav and George Kapperad. 1983. House flies (*Musca domestica*) as possible vectors of *Campylobacter fetus* subsp. *jejuni*. Applied and Environmental Microbiology. *45*:381-383.

62. Rothenberg, P. J., N. J. Stern, and D. C. Westhoff. 1984. Selected environmental broths for recovery of *Campylobacter jejuni* from foods. Appl. and Environ. Microbiol. *48*:78-80.

63. Russ, C. F. and W. A. Yanko. 1981. Factors affecting salmonellae repopulation in composted sludges. Appl. Environ. Microbiol. *41*:597-602.

64. Sack, R. B. 1975a. Human diarrheal disease caused by enterotoxigenic *Escherichia coli*. Ann. Rev. Microbiol *29*:333.

65. Schiemann, D. A. 1982. Development of a two-step enrichment for recovery of *Yersinia enterocolitica* from food. Vol 43, No. 1., p. 14-27.

66. Sepp, E. 1980. Pathogen survival in sludge stabilization processes. California Department of Health Services, Sanitary Engineering Section, Berkeley, Ca.

67. Shayegani, Mehdi, W. B. Stone, I. DeForge, T. Root, L. M. Parsons, and P. Maupin. 1986. *Yersinia enterocolitica* and related species isolated from wildlife in New York State. Applied and Environmental Microbiology. *52(3)*:420-424.

68. Smith, E. M. and C. P. Gerba. 1982. Development of a method for detection of human rotavirus in water and sewage. Appl. Environ. Microbiol. *43*:1440-1450.

69. Sorber, C.A. and B.E. Moore 1986. Survival and transport of pathogens in sludge-amended soil: a critical literature review. Available from NTIS, Springfield, VA. Cooperative Agreement No. CR811918-01-0.

70. Swaminathan, B., M. C. Harmon and I. J. Mehlman. 1982. A review- *Yersinia enterocolitica*. Journal of Applied Bacteriology, *52*:151-183.

71. Vogt, R. L., H. E. Sours, T. Barret, R. A. Feldman, R. J. Dickinson, and L. Witherell. 1982. *Campylobacter* enteritis associated with contaminated water. Annals of Internal Medicine. *96*:292-296.

72. Walker, A. S., and W. A. Yanko. 1987. SBG Sulfa enrichment for the quantitative isolation of salmonellae from sewage and compost. In: Analytical Techniques and Residuals Management in Water Pollution Control. Water Pollution Control Federation Specialty Conference Series, June 1-2, 1987, pp. 331-337.

73. Ward, R. L., G. A. McFeters and J. G. Yeager. 1984. Pathogens in sludge: occurrence, inactivation, and potential for regrowth. Sandia National Laboratories, Albuquerque, New Mexico. Available from NTIS, Springfield, VA.

74. Weagant, S. D., and C. A. Kaysner, 1983a. Modified enrichment broth for isolation of *Yersinia enterocolitica* from nonfood sources. Applied and Environmental Microbiology. 45(2):468-471.

75. Weagant, S. D. 1983b. Medium for presumptive identification of *Yersinia enterocolitica*. Appl and Environ. Microbiol. 45(2):472-473.

76. WHO Euro Reports and Studies. 1981. The Risk to Health of Microbes in Sewage Sludge Applied to Land. 54:1-27 World Health Organization.

77. WHO Scientific Working Group. 1980. *Escherichia coli* diarrhoea. Bull. World Health Org. 58:23-36.

78. Yanko, W. A., C. D. McGee, and J. S. Glass. 1983. The fate of viruses during composting of sewage solids. A review of the problem and results of field studies. In: windrow and static pile composting of municipal sewage sludges, M. D. Iacaboni, J. R. Livingston, T. J. LeBrun. Los Angeles County Sanitation Districts for EPA, Wastewater Research Division, Municipal Environmental Research Laboratory, Cincinnati, Ohio.

79. Yeager, J. G. and R. L. Ward. 1981. Effects of moisture content on long-term survival and regrowth of bacteria in wastewater sludge. Appl. Environ. 41:1117-1122.

APPENDIX A

MICROBIOLOGICAL METHODS EVALUATION AND DEVELOPMENT

FUNGI

Methods for enumerating fungi were thoroughly evaluated. It should be kept in mind that the term "total fungal count" is somewhat of a misnomer and that no one medium or incubation temperature will be appropriate to recover all of the fungi potentially present. Dr. Martin Stoner (California Polytechnic University at Pomona, mycology consultant for the project) suggested several media to evaluate which included the following:

1) Alpha-cellulose agar - isolation of cellulose degrading fungi, regularly supports growth of Gliocladium and Trichoderma.
2) Diet-food medium with antibiotics and surfactant-general isolation medium, especially for the recovery of Penicillium, Gliocladium, and allied genera.
3) Peptone-pentachloronitrobenzene medium (PCHB) - very selective for Fusarium sp.
4) Potato dextrose agar - with antibiotics and surfactant, general isolation medium for fungi.
5) V-8 vegetable juice agar - selective isolation of zygomycetes and water molds.
6) Rose bengal agar - recommended in Standard Methods (APHA, 1985) for fungal plate counts.

Early in the evaluation, nine different compost samples were plated on the above media to get a general assessment of populations present and to practice fungal identification procedures. The preliminary experiments revealed that few fungi were detected from compost samples with alpha-cellulose agar or PCNB medium (both media are selective for cellulose degrading fungi). At this point a decision was made to eliminate the alpha-cellulose and PCNB from further evaluation.

The remaining media were compared quantitatively in a series of five experiments. Samples used were composites of compost products from sites IX-A-3, IX-A-4 and IX-A-5. Each medium was incubated at three temperatures: room termperature (18 - 23 C), 35 C and 42 C. The results are summarized in Table A-1. Overall the rose bengal medium yielded the greatest number of fungal colonies and the greatest diversity of species and 35 C incubation was the most productive temperature. Although the rose bengal medium was clearly the most productive medium in this comparison, other factors also need to be considered in the final analysis. Among these are the groups of fungi selected by the medium/temperature combination and the colonial morphology and growth characteristics of the fungi on the medium.

Most of the fungi isolated from the compost samples were members of three groups, the genera *Aspergillus* and *Paecilomyces*, and the Class Zygomycetes; these produced very characteristic morphological structures. The V-8 juice agar was quantitatively the least productive medium, but was very specific for the Zygomycetes. In a similar vein, the 35C incubation temperature was most productive, however, 42-44C will select for the thermotolerant fungi and this group may have some indicator or correlative value or may have associated health implications.

The final media selection attempted to optimize and balance these various considerations. The Cooke rose bengal medium (Difco) with 0.05g/L chloramphenicol and 0.1 percent Tergitol incubated at 35 C was used for the "total fungal count." V-8 juice agar was used in conjunction with the rose bengal at 35 C to select for Zygomycetes.

It was originally proposed that oxgall medium incubated at 44 C would be used for thermotolerant fungi. A subsequent comparison (unpublished data) found the rose bengal medium superior for this purpose due to better suppression of the bacterial population. Cooke rose bengal with chloramphenicol and 0.01 percent Tergitol, incubated at 44 C was used for the thermotolerant fungi, including *Aspergillus fumigatus*.

Fungal identifications were based on a macroscopic to microscopic progression. The first step was the macroscopic observations of colonial morphology, color, texture and other qualitative features. This was followed by a microscopic examination of the reproductive structures. In general, the actual form of reproductive parts or other specified components usually take precedence over color, colony texture, or other more qualitative features that are subject to variation with environmental conditions.

The observed fungal characteristics were then compared to those listed in one or more taxonomic keys (Raper *et al* 1965, Barnett *et al* 1972). The keys used to identify fungi were not entirely consistent and occasionally more than one approach in a keying system had to be used. The final determinations of fungal identification were based on the closest or most accurate species description. When an isolate could not be identified, it was subcultured and sent to the consultant for evaluation.

Table A-1 Summary of Total Fungal Counts on Selected Media at Three Incubation Temperatures [a]

Incubation Temp	CFU/mL Compost Suspension [b]				Grand Mean Temp [c]
	Diet Food	Pot Dex	Rose Bengal	V-8 Juice	
Room Temp (18-23C)	190	170	230	17	150
35 C	700	490	700	190	520
42 C	280	280	810	31	350
Grand Mean Media [d]	390	310	580	79	_____

a. Samples were composites of sites IX-A-3, IX-A-4 and IX-A-5.

b. Each value is the arithmetic mean of 15 determinations (5 trials, triplicated plates in each trial at countable dilution).

c. Arithmetic mean for all media at the given temperature.

d. Arithmetic mean for all temperatures for a given medium.

COLIPHAGE

Methods for detecting coliphage in sludges had to be developed for this study. The investigation was divided into three tasks. The first task involved controlling bacterial contamination of the sample without causing a phage titer loss. The second task was to maximize the recovery of phage from the solids using various mechanical manipulations and eluents. The third task was to compare four strains of E. coli to determine which would recover the greatest number of coliphage from sludge samples.

Initial decontamination studies using primary and secondary wastewater examined diluting the sample, centrifugation (IEC head 870; 2000 x g, 10 min; 15,000 x g, 10, 30 and 45 min) chloroform treatment (APHA 1985), non treated 0.22 micrometer porosity filters, and filtration through filters pretreated with 10 ml of 3% beef extract. The arithmetic mean indigenous phage titers from 5 trials assayed by the plaque technique (Adams 1959) are demonstrated in Figure A-1. The samples using the dilution and centrifugation techniques were not adequately decontaminated. Indigenous phage titers of 370 PFU/mL were observed using an untreated filter, 1,800 PFU/mL using chloroform decontamination, and 3,500 PFU/mL using a treaed filter for decontamination.

Because decontamination of the sample by filtration removed particulate matter which would be significant in sludge samples, the next set of experiments examined eluting particulate associated phage and centrifuging to remove the solids in primary wastewater. Beef extract (3% w/v) was added to the wastewater. The mixture was blended in a Waring blender, sonicated as described by Glass et al (1978) and divided into centrifuged (IEC #872 3500 x g, 15 min.) and non centrifuged portions. These were split and decontaminated by chloroform or filtration (0.22 micrometer porosity Millex). Wastewater without beef extract added was also blended and sonicated; it was divided into 3 portions and 1 portion decontaminated with chloroform, 1 portion filtered through a Millex and 1 portion filtered through a beef extract treated Millex.

Figure A-2 shows that without beef extract present, relative recovery from the primary wastewater was the same as observed from the first series of experiments; phage adsorbed to untreated filters and were partially inactivated by chloroform. When beef extract was added to the wastewater, phage recovery increased in all cases indicating phage were eluted from the solids. None of the results for the beef extract treated samples were significantly different (n=5, P=<0.05) indicating that centrifuging did not affect the eluted phage. These results also suggest that beef extract may mitigate the detrimental effects of chloroform treatment.

Next the effect of mechanical manipulation was examined independently by keeping the addition of beef extract constant and varying combinations of blending, sonication and centrifugation. The results, shown in Figure A-3 show only that a somewhat higher phage titer was obtained using the condition with fewest manipulations.

In the next set of experiments anaerobically digested sludge samples were blended, sonicated and centrifuged and eluents were varied. The eluents compared were: 3% beef extract at pH 7.2; 3% beef extract at pH 9.5; Trypticase soy broth; 0.25 M, pH 11.5 glycine with 0.05 M EDTA; and 5% casein at pH 9.5. The mean recoveries of 3 experiments are presented in Figure A-4. The only significant difference between eluents was that high pH glycine was the least efficient. All other eluents worked equally as well with a trend toward the pH 9.5 beef extract giving somewhat better recovery.

At this point a different approach to controlling unwanted bacterial growth was evaluated. Eluents were assayed using an MPN technique described by Kott (1966). Lauryl Tryptose broth (LTB), a somewhat selective medium for coliforms, was used in hopes of controlling unwanted baterial growth. A nonselective medium, Trypticase soy broth (TSB), was also used for comparison. The experimental design is shown in Figure A-5.

The interaction between the five eluents and the two media used in the MPN assay as well as the decontamination with chloroform and filtration (treated filters with assay by plaque technique) was examined by comparing these data in an ABS matrix (Boik 1979). Average values were obtained for each condition. Data for the eluents independent of decontamination were averaged by collapsing across the rows and average values for the decontamination techniques independent of eluent were averaged by collapsing down the columns. The row and column means are known as marginal means and are represented in Figures A-6 and A-7. Elution from solids was best obtained using the 9.5 pH beef extract and decontamination using a treated filter and plaque assay gave the most efficient recovery of phage. The MPN assay procedure with either medium did not give results comparable to a direct decontamination and plaque assay technique.

The final task of the investigation was a comparison of the host strains *E. coli* B, *E. coli* K12Hfr, *E. coli* C-3000 and *E. coli* C. Indigenous phage in 16 anaerobically digested sludge eluates were simultaneously assayed with all four cell cultures. The total number of plaques obtained from each strain is represented in Figure A-8. Here it can be seen that *E. coli* B was the least effective host cell with increasing recoveries from

K12Hfr, C-3000 and *E. coli* C. *E. coli* C gave a statistically significant (P=>0.05) higher recovery value.

To summarize, the method selected that optimized coliphage detection from composted sewage solids was to blend the sample in pH 9.5, 3% beef extract, centrifuge out the particulates, decontaminate the sample using a pretreated 0.22 micrometer porosity filter and assay the sample on *E. coli* C using the plaque technique.

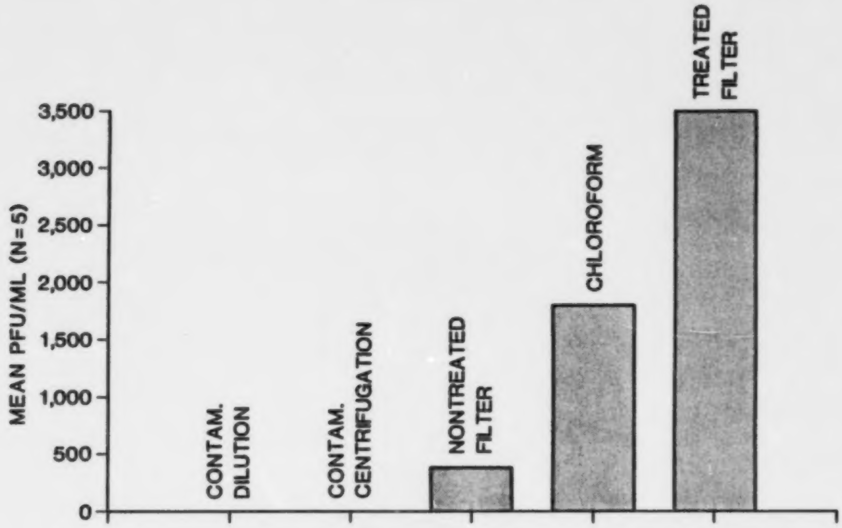


FIGURE A-1 PHAGE TITER - DECONTAMINATION INTERACTION

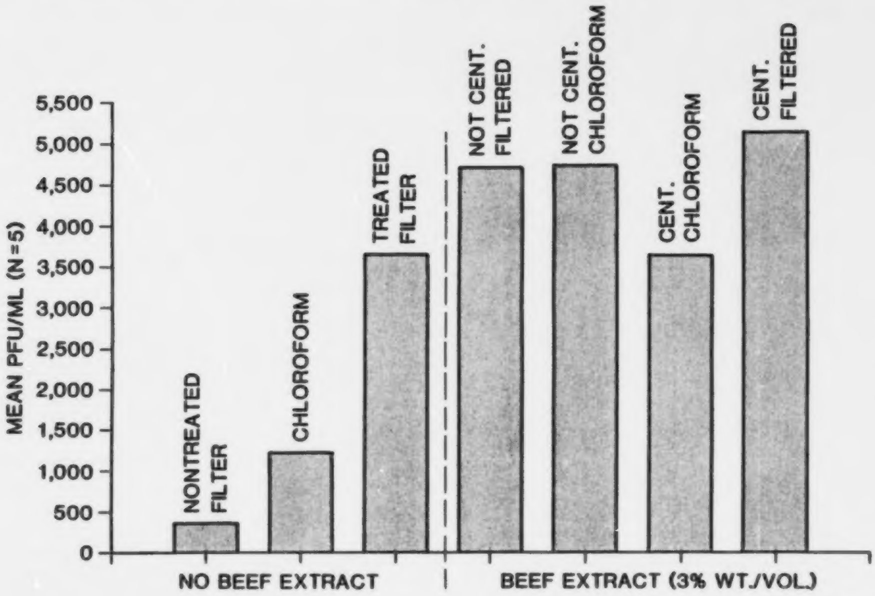


FIGURE A-2 PARTICULATE ASSOCIATION - DECONTAMINATION INTERACTION

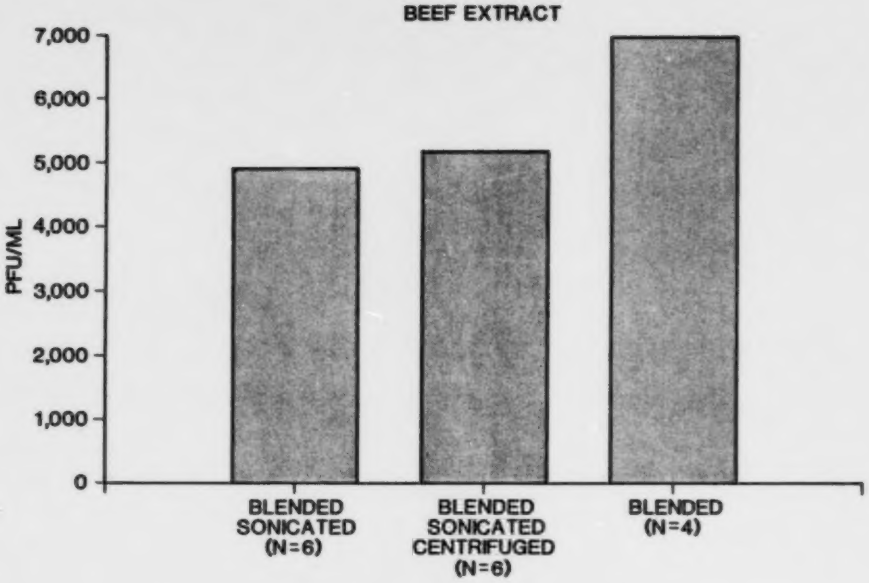


FIGURE A-3 MECHANICAL MANIPULATION

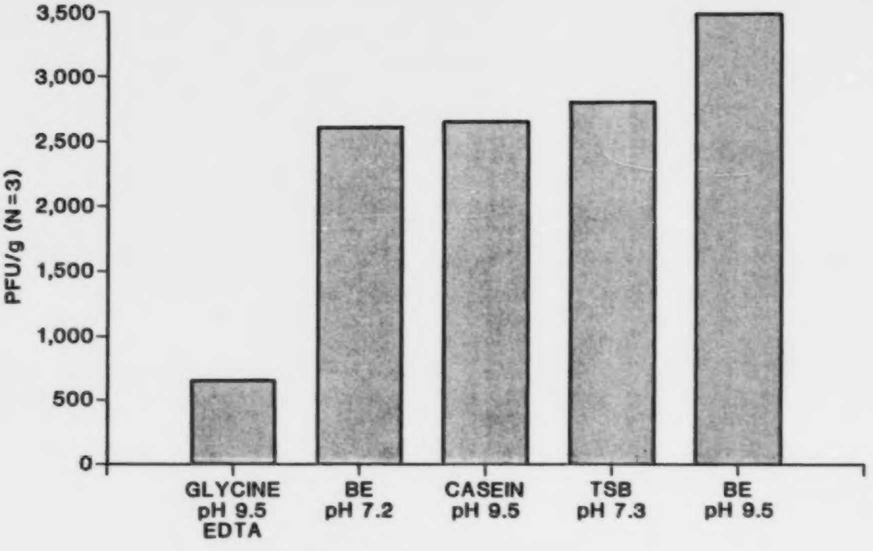


FIGURE A-4 ELUENTS

Figure A-5 MPN Assay

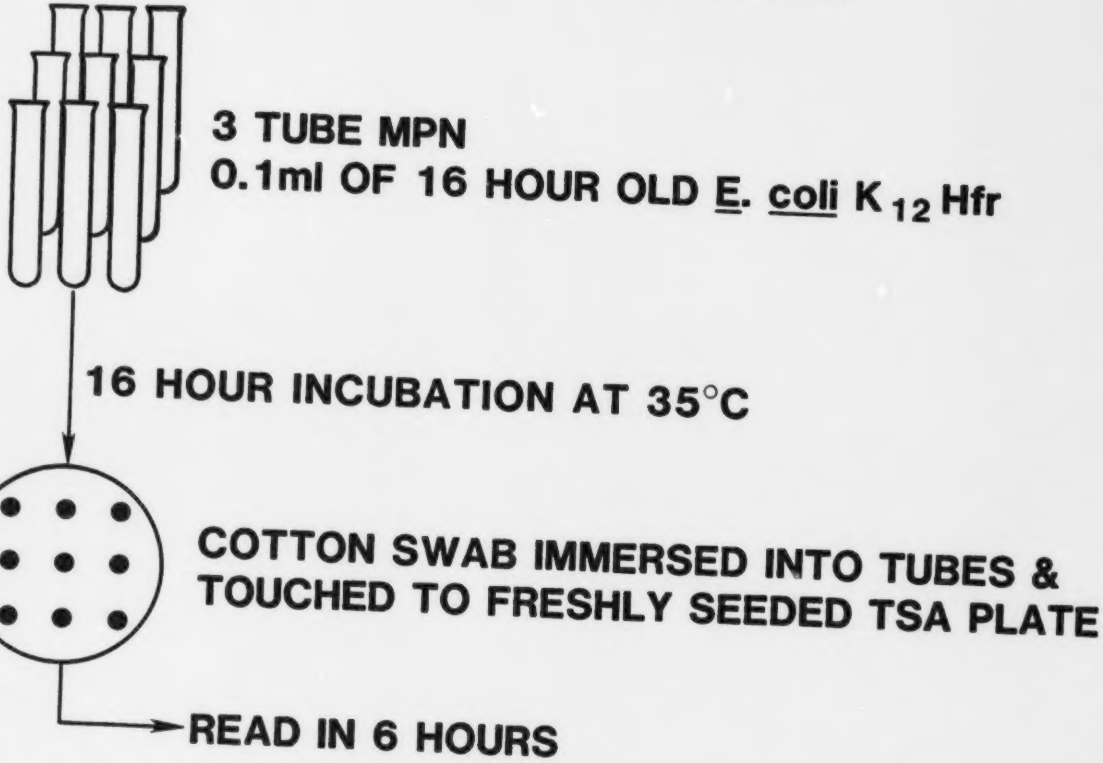
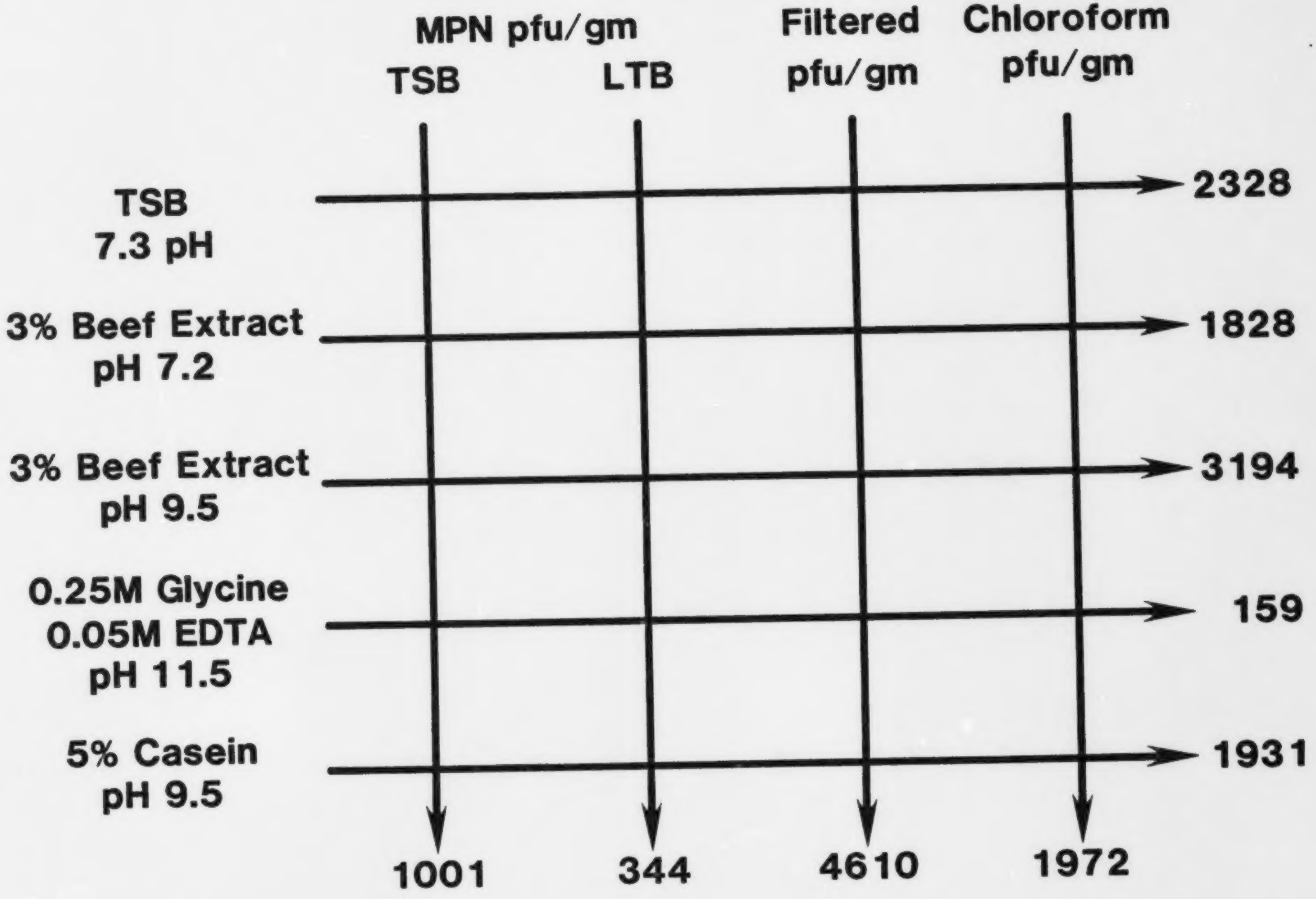

3 TUBE MPN
0.1ml OF 16 HOUR OLD E. coli K 12 Hfr
16 HOUR INCUBATION AT 35°C
COTTON SWAB IMMERSED INTO TUBES &
TOUCHED TO FRESHLY SEEDED TSA PLATE
READ IN 6 HOURS

Figure A-6 Eluent - Decontamination Interaction



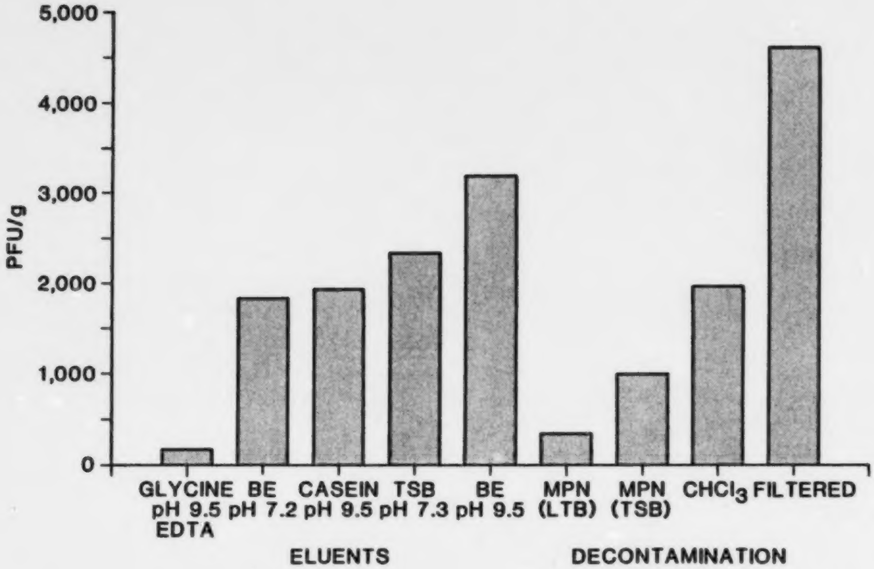


FIGURE A-7 ELUENT - DECONTAMINATION INTERACTION

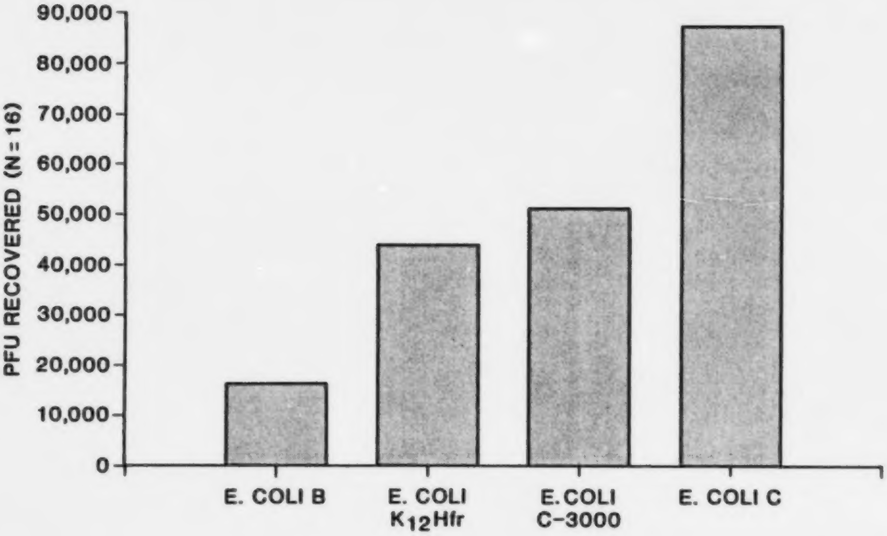


FIGURE A-8 COLIPHAGE RECOVERY ON FOUR HOST CELLS

ENTEROTOXIGENIC ESCHERICHIA COLI

Research into the causes of acute diarrhea has implicated *E. coli* as one of the causative microorganisms. A World Health Organization (WHO) working group in 1980 defined three groups of *E. coli* as important diarrheal pathogens: (a) the enterotoxgenic *E. coli* (ETEC) which produce enterotoxins that cause diarrhea in infants, young children and adults in developing countries as well as travelers to those countries; (b) enteropathogenic *E. coli* which have been responsible for frequent outbreaks of infantile diarrhea in many parts of the world and are known to belong to specific serotypes; and (c) enteroinvasive *E. coli* which are tissue invasive and have a pathological behavior similar to *Shigella*.

The cholera-like symptoms produced by the ETEC are the result of enterotoxins which have been generally divided into either heat-stable (ST) or heat labile (LT) categories. The LT is immunologically related to the cholera toxin. The ST is a relatively low molecular weight non-antigenic enterotoxin. The ability of any *E. coli* to produce these enterotoxins is carried by plasmids. Plasmid mediation of toxin production means that probably any *E. coli* strain might contain or lose the controlling plasmid thus ruling out significance of a particular serotype as being a causal agent for acute diarrhea. This was confirmed by Goldschmidt and DuPont (1976), who showed a lack of correlation between classical enteropathogenic serotypes of *E. coli* and virulence properties in animal models. At this time, there is no suitable laboratory method for differentiating the enteropathogenic or enteroinvasive strains. There are adequate methods available to test for the enterotoxin produced by the enterotoxigenic *E. coli*.

In order to assess the toxin producing *E. coli* populations in this study, a plan was developed to test the *E. coli* population in each of the samples. The in vitro cell culture assay for enterotoxin described by Sack (1975) was selected as the diagnostic tool for this purpose. In this test whole bacterial cultures are briefly exposed to Y-1 adrenal cells in tissue culture. A rounding response of the Y-1 cells within 18 to 24 hours is considered evidence of toxin production by the bacterial culture. Sack's test was selected because it is relatively non subjective, accurate, did not require removal of the bacterial cells by filteration or inactivation with chloroform, produced results in 18 to 24 hours, and growing the cells in microtiter plates permitted screening a large number of samples efficiently.

Sample testing was initially delayed due to difficulties encountered with the Y-1 cell culture. The first vial of frozen cells received from the American Type Culture Collection (ATCC) contained only a few viable cells even though the vial had been handled according to directions. Before ordering a second vial, a technical representative from ATCC and the person growing these cells in Dr. Sack's laboratory at John Hopkins were consulted. As a result some changes were made in the handling procedures. Typically, cells are frozen with a protective freezing additive,either glyce rol or dimethyl sulfoxide (DMSO). Standard thawing procedure is to change the culture medium 24 hours after thawing a vial to remove the freezing additive. It was pointed out by the ATCC representative that a characteristic of the Y-1 line is a delayed attachment to the flask following thawing. He recommended that the first medium change be postponed until 48 hours after thawing. Dr. Sack's cell culture technician indicated that she thought the cells were extremely sensitive to osmotoc pressure and recommended that upon thawing the vail, the first 10 mL of fresh medium should be added drop by drop after which the remaining medium could be added. This procedure was in lieu of adding the contents of the frozen vial directly to a flask containing the entire amount of medium. Both modifications were tried with the next vial, and it did grow. It was the virologist's opinion, however, that the initial vial simply did not contain many viable cells.

After getting the cells to grow from frozen stock, subculturing problems were encountered. Occasionally, the cells would not grow following trypsinization. The trypsin with EDTA was suspected and switched to 0.1% plain trypsin. This change helped.

During the period of cell culture problems with the Y-1 cells, Vero, BGMK, V-79, HeLa and MA104 cell lines were evaluated as substitutes. Dr. Sack's laboratory provided three toxigenic E. coli strains that had been stable for toxin production for many years, and some cholera toxin, all of which were used as positive controls for the cell line evaluations. No other cell line gave as clear cut a response to the toxin as did the Y-1 cells. Eventually, the Y-1 line began to grow well; finding a substitute cell line was abandoned.

With the assay system established, the procedure for screening samples was examined. An initial experiment where the samples were obtained from EC tubes of the fecal coliform test failed because the sterile EC medium caused cell morphology changes and cell mortality. An attempt to obtain cultures for testing from the lauryl tryptose broth failed because the diverse bacterial population overwhelmed the antibiotics in the culture medium.

Apparently these problems were unique to the compost samples since Dr. Sack did not experience similar problems using the same technique. The following approach was eventually selected: streak positive EC tubes from the 10 mL inoculum of the fecal coliform test onto M-Endo LES plates; incubate at 35C for 18-24 hours; pick five representative sheen producing colonies from each plate and inoculate onto trypticase soy agar slants (BBL); incubate the slants 18-24 hours at 35C, store the slants at 5C prior to toxin assay (Cultures were expected to be stored 2 to 3 weeks prior to conducting the toxin assay. Due to cell culture problems with the Y-1 cells, a testing backlog developed and some cultures were stored as long as 16 weeks.); one day before the assay, pool the 5 slants from each sample by making transfers into a single tube of trypticase soy broth and incubate 18-24 hours at 35C; inoculate 50 microliters of the 18-24 hour broth culture into triplicate microtiter plate wells containing a 72 hour monolayer of Y-1 cells. After a 15 minute exposure time aspirate the inoculum, wash with PBS, and add fresh medium; observe the cells at 24 and 48 hours for characteristic rounding. Every assay contained three positive control strains of toxigenic *E. coli*, and three confirmed negative cultures from our own culture collection.

Based on estimates by Geldreich (1972), it was assumed that the toxigenic *E. coli* populations would be low when compared to the fecal coliform population and therefore would probably only be detected in low dilutions in a dilution test. Only EC tubes resulting from 10 ml inocula were examined. For enumeration purposes, an MPN value was computed based on single dilution calculations.

A compost sample spiked with 3 mL of an 18 hr TSB broth culture of a toxin producing *E. coli* strain was tested with the assay procedure. The spike was detected so the method was applied to each of the 500 samples in the study.

TOTAL ENTERIC PLATE COUNT

IDENTIFICATION OF ISOLATES FROM MACCONKEY AGAR

The total enteric plate count data were obtained by the spread plate technique. Blended sample, serially diluted was plated on MacConkey agar and incubated 48 hours. Data were reported as log CFU/mL.

Colonies were picked off the primary spread plate medium and transferred onto a trypticase soy agar (TSA) medium supplemented with ten percent dextrose and containing a bromthymol blue indicator. This step was added to insure isolate purity and to aid in distinguishing fermenters from nonfermenters. Isolated colonies on the dextrose medium were tested for oxidase reaction and simultaneously inoculated into fermenter/nonfermenter broth for use in the BBL Minitek System for the Identification of Enterobacteriaceae and Nonfermenters.

Oxidase positive isolates were inoculated onto the nonfermenter panel. Oxidase negative, dextrose negative colonies were also placed on the nonfermenter panel. Oxidase negative, dextrose positive colonies were inoculated onto the Enterobacteriaceae II panel. Dextrose utilization could not be determined as oxidative or fermentative on the dextrose plate medium and due to the necessity for expediency, standard Oxidation/Fermentation (OF) tests were not run. Therefore, the dextrose well in the Enterobacteriaceae II panel was overlaid with sterile mineral oil as a double check on the dextrose reaction. A few oxidase negative colonies utilizing dextrose on the plates were actually nonfermenters and were inoculated onto the wrong panel. Oil overlay of the dextrose well indicated when the dextrose utilization was nonfermentative; these organisms were reinoculated to the correct panel.

Errors in some early identifications occurred due to this lack of distinction between oxidative and fermentative use of dextrose. Some isolates gave reactions on Minitek Enterobacteriaceae II typical of *Shigella* sp. These isolates were submitted to the Los Angeles County Public Health Department, and most were identified as nonfermenters, thus failing to confirm their identity as shigellae. A few were identified as *Citrobacter sp*.

After implementing the oil overlay of dextrose, the only other unusual isolates obtained were of the genus *Bordetella*. Additional tests to confirm the identification were recommended by BBL. In most cases isolates identified as Bordetella bronchiseptica were non-motile and therefore did not confirm as Bordetella. Those isolates identified as Bordetella parapertussis were non-motile and additional tests were needed to confirm that they were not Bordetella parapertussis. Other tests utilized were gelatin hydrolysis, hemolysis, and tetrazolium reduction. All of the Bordetella parapertussis isolates were non-hemolytic, thus failing to confirm as Bordetella.

Many samples contained organisms which formed pin point colonies on MacConkey agar at 48 hours and subsequently did not grow when picked and transferred to the dextrose plating medium. These small colonies were not present on MacConkey at 24 hours and were most likely not true "MacConkey positive" organisms and should not have been included in the identification. These organisms still appear as a percentage of the total sample and are designated "pick did not grow".

The first method investigated for the identification of isolates from MacConkey agar was one similar to that used for the identification of fungal isolates. Fungal colonies that were morphologically alike were counted and one of each type identified. The inability to discriminate between colonies based on morphology made this method impractical for the identification of bacterial isolates. Isolates to be identified were then obtained by plating the sample on MacConkey agar in petri dishes imprinted with a Quebec colony counting grid. Those colonies lying within the twelve squares were transferred to dextrose medium and later identified.

In the early stages of testing, it was discovered that picking colonies from the grid areas on the petri dish could result in over 40 isolates per sample which would have been too time consuming and costly to identify using the identification system we had chosen (BBL Minitek System for the Identification of Enterobacteriaceae and Nonfermenters). The number of grids picked was decreased and depended upon the colony count obtained. Ranges were defined as follows: All twelve grids were picked if the enteric plate count was between 30 and 50 CFU, half of the grids were picked if the enteric plate count was between 51 and 100 CFU and one fourth of the grids were picked if the enteric plate count was between 101 and 300 CFU. These ranges were selected to economize on both time and reagents.

Since isolates were picked from the "countable plate", enteric organisms detected in other tests (Yersinia and Salmonella) were often not identified using Minitek. The most probable reason for missing these isolates was that the countable range for the total enteric plate count occurred at a dilution much higher than the level at which specific enterics were detected in other tests. A sample with 1000 Salmonella per 100 mL of blended sample may not have Salmonella as a Minitek isolate if the total enteric plate count was orders of magnitude higher.

The method for obtaining the total enteric plate count and identification of isolates from MacConkey agar underwent changes as problems were encountered. Many isolates gave profile numbers not in the BBL directory. These profile numbers were called into BBL technical services for identification. Each identification is accompanied by a confidence value and biotype validity.

The confidence value is the likelihood that an unknown organism is a given species and is expressed as a percentage. Therefore, if an unknown organism is identified as a member of a species in a group, the confidence value is the percent probability that it is that species.

The biotype validity is an expression of the "typicality" of the isolate compared to the species in which it is placed. It is the ratio of likelihood of the isolate to that which would have been obtained if the results had agreed with its respective probability. A biotype validity of one indicates that the results of the isolate matched exactly the results that would have been expected for the species to which it belongs.

According to BBL technical services, a good identification should have a confidence value no lower than 85 percent. The biotype validity could vary from 1 to over 100,000 depending upon the number of biochemical tests that match the identification and the number of strains in the Minitek database.

Several of the identifications obtained had low confidence values and/or a high biotype validity. As an example, Pseudomonas stutzeri, profile number 644216, had a confidence value of 66.08% and a biotype validity of 1481. This could be due to the fact that Minitek test kits were designed for use in a clinical setting. Environmental isolates therefore, may not be identified as accurately since few strains are included in the Minitek database. On the other hand, since the Minitek database does contain clinically significant strains, there is a positive bias toward identification of an isolate as a pathogen. Therefore it is probable that if an enteric pathogen were isolated, it would be identified as such. In practice, several isolates were identified as pathogens. Supplemental tests were conducted to support or refute those identifications.

Although the certainty of individual identifications is variable, with the large number of isolates identified a good profile of species present can be obtained.

CAMPYLOBACTER

A preliminary literature review found no references concerning campylobacters in sludge; however, much work had been directed toward detecting these organisms in food. Numerous media modifications had been reported to improve Campylobacter recoveries from various types of samples. These references were evaluated and the most promising were selected for laboratory evaluation.

Many difficulties were encountered with the procedures for Campylobacter isolation and enumeration. The first series of experiments was designed to select an enrichment broth. Four enrichment media which had been described in the literature (cited in Table A-2) were compared. These media isted with results of the comparison in Table A-2. The experiment was set up in two parts. First, the growth of Campylobacter in the enrichment was compared. Each 50 mL volume of broth was inoculated with equal amounts of suspension of C. jejuni and incubated in anaerobic jars with Campy Paks (BBL for 24 hours at 42 C. The Campylobacter concentration in each broth was then determined by each broth was then determined by plate count on commercially prepared Campy Agar (Gibco).

The second part of the experiment compared the ability of the enrichment media to inhibit growth of background organisms present in sludge. Again, each 50 mL bottle of broth was inoculated with 5 mL of a 20% compost suspension and incubated for 24 hours at 42 C in a microaerophilic atmosphere (Campy-Pak).

Beginning and final concentrations for both experiments are summarized in Table A-2. After 24 hours incubation, Campylobacter was not detected in two of the enrichment media. The Doyle and Roman (1982) broth (DRB) yielded the highest number of Campylobacter. Inhibition of background organism growth was not significantly different in any of the media. Although loss of the Campylobacter in two of the enrichment media seemed unusual, recently published comparisons of Campylobacter enrichments (Heisick 1985, Rothenberg et al 1984, Beuchat 1985) also reported DRB to be superior or equal to others compared. Therefore, the DRB enrichment medium was selected for further evaluation.

The next series of experiments was designed to determine quantitative recovery of Campylobacter from spiked compost. A compost suspension was seeded with Campylobacter. DRB was inoculated in a multiple tube dilution test and incubated for 24 hours at 42 C in jars with a microaerophilic atmosphere (BBL Campy-Pak). The enrichment tubes were streaked to commercially prepared Campy Agar (Gibco) and incubated under the same conditions. No *Campylobacter* was detected, however, the seed was fairly low (10 CFU/mL). The experiment was repeated with a higher seed concentration (50 CFU/mL) and numerous positive controls. Again, no *Camplyobacter* was detected. It was noted that positive control plates, i.e., plates streaked with a *Campylobacter* culture, that were in jars along with plates streaked from compost enrichment tubes, also did not grow. Some control plates that incidentally were in a jar by themselves did grow *Campylobacter*. It was then hypothesized that the background population in the compost, when streaked to the Campy plates, used up the oxygen in the microaerophilic atmosphere causing the jars to go anaerobic. The anaerobic environment in turn prevented the *Campylobacter* from growing. Additional experiments confirmed this hypothesis.

To compensate, a gas cylinder was ordered containing the recommended atmosphere, 5% oxygen, 10% carbon dioxide, and 85% nitrogen. The anaerobic jars were ported and set up with self closing quick connect fittings. A gas line was run into the 42 C incubator and the gas was warmed and humidified by bubbling through a flask of water held in the incubator. One reference reported that a constant flow of gas was a superior method for recovering *Campylobacter* from milk (Hunt *et al* 1985). It was hoped that maintaining the proper incubation atmsophere would alleviate the initial recovery problems.

Recovery experiments with *Campylobacter* seeded into compost suspensions were then resumed. The new system was shown to maintain microaerophilic conditions, nevertheless levels of 240 CFU/mL of *Campylobacter* seeded into sludge could not be detected. When the seed level was increased to 10^3, the *Campylobacter* could be detected from the higher dilution tubes of the MPN test but not from the lower dilution tubes. This pattern suggested that the large background population in the sludge still overwhelmed *Campylobacter* in spite of the enrichment medium.

At this point it was decided to evaluate a modification of the enrichment medium. The current edition of *Standard Methods* (APHA) discusses *Campylobacter* isolation from water and recommends the addition of 1.5% ox bile to the enrichment medium. Interestingly, the reference cited for this modification was not a technical paper; it was a letter to the editor in a veterinary journal (Oosteron *et al* 1981. More recent publications which discuss enrichment and isolation of *Campylobacter* (Heisick 1985) made no mention of using ox bile enrichments so it had not been incorporated into the enrichments evaluated for this study.

Since part of the recovery problem appeared to be related to competition from other organisms in the sludge, it was decided to evaluate modifications to the DRB enrichment (DRE) that might help inhibit background organisms. Bergey's Manual (1984) indicated that most *Campylobacter* species are resistant to 1.0% bile. Also, ox bile or bile salts is commonly employed in enteric media. Considering the *Standard Methods* (APHA 1985) recommendation, the DRB broth was modified with the addition of 1.5 g/L bile salts (a more purified and concentrated form of ox bile).

Initial experiments confirmed the observation of Oosterom *et al* (1981), that the addition of bile to *Campylobacter* media greatly stimulated the growth of the *Campylobacter*; growth in DRB broth with bile salts added increased by more than an order of magnitude.

A second modification of the isolation procedure was designed to take advantage of the small size and active motility of the organism. *Campylobacter* isolation procedures for water recommend prefiltering the sample through a 0.6 micrometer porosity filter. *Campylobacter* will pass through the filter while most other bacteria will be retained. Unfortunately, sludge and compost suspensions cannot be filtered.

It was noted in our lab, however, that in broth cultures incubated in the microaerophilic atmosphere, the *Campylobacter* tend to grow in the upper portion of the culture tube or bottle. Also, when compost suspension is inoculated into a broth medium, the compost solids tend to settle out in the tube during 18-24 hr. stationary incubation. The "clarified, supernate" medium can be withdrawn from the tube and passed through a 0.6 micrometer filter at that point.

By use of this procedure, it was hoped that any viable *Campylobacter* in the sludge suspension would migrate to the upper portion of the DRB broth while the sludge solids settled out. At the same time, the stimulatory effect of the bile salts might help the organism grow in the presence of the competing population. Then, even if the ratio of background population to Campylobacter was still too high for the *Campylobacter* to be detected on isolation media, the filtration and reinoculation of filtrate into fresh enrichment medium should permit the *Campylobacter* to grow to levels where they could be readily detected.

Experiments with pure cultures confirmed that each step of this procedure was conceptually valid. Again, when low numbers of *Campylobacter* were seeded into sludge or compost, they were not recovered. If the seed concentration was high enough to recover the *Campylobacter* by direct plating techniques, they were generally also recovered from enrichment broths. When the sludge was seeded at a level below that detectable by direct plating ($<10^3$ CFU/mL), the available enrichment media appear inadequate to select for the *Campylobacter* in the presence of the large diverse sludge populations.

An exact threshold for recovery was not determined. Low level seeds in these experiments generally meant approximately 100 or less organisms per mL. Seeded campylobacters were usually recovered by direct plating of compost suspensions containing around 1,000 or more cells per mL. Compost suspensions used in the seeding experiments contained in excess of a million background organisms per mL.

The purpose of enrichment is to provide a cultural environment which will favor the growth of a particular bacterium making it easier to isolate from a mixed population. Available enrichment media for *Campylobacter* were apparently unable to provide a suitable growth environment with compost suspensions. Beuchat (1985) reported similar results from an evaluation of media and methods for detecting and enumerating *Campylobacter jejuni* in refrigerated chicken meat. He indicated that, without exception, direct plating of samples on isolation agars was superior to the MPN method for enumerating *C. jejuni* in refrigerated chicken.

Table A-2. Comparison of Enrichment Media for Isolation of Campylobacter

Medium	Campylobacter CFU/mL		Background Organisms CFU/mL	
	Initial	24 hrs	Initial	24hrs
Rosef & Kapperud (1983)	74	<10	1.4×10^6	2.0×10^8
Doyle and Roman (1982)	74	44,000	1.4×10^6	9.2×10^7
Thioglycollate Broth Plus Antibiotics(GIBCO)	74	7,000	1.4×10^6	3.9×10^7
BEM (Rogol et al 1985)	74	<100	1.4×10^6	2.0×10^8

YERSINIA ENTEROCOLITICA

A literature search was conducted to evaluate procedures for recovering Yersinia from sewage sludge. No procedures were found, however many references contained procedures for recovering Yersinia from food and water. Selenite-F and more recently Peptone-Sorbitol-Bile Salts (PSB) (Weagant et al, 1983a) were recommended enrichment broths. Other enrichment procedures were reported but most were more complex and many of the enrichment broths were found too selective for the various serogroups of Yersinia (Schiemann, 1982). Since Yersinia can grow faster at cold temperatures than other bacteria, incubation was recommended at 4 C for up to 4 weeks. Initial tests with primary sludge demonstrated that PSB enrichment broth was somewhat more selective than Selenite-F. PSB and Selenite-F enrichment were incubated at 4 degrees C for up to 4 weeks. Fresh dewatered primary sludge was used as the sample. Enrichment broths were streaked onto Yersinia Selective agar (YSA, also known as CIN agar) at the end of weeks 1, 2, 3, and 4. Plates were incubated 48 hours at 26 degrees C. At weeks 1 and 2 there was very little growth from PSB enrichment tubes and light to moderate growth from the Selenite-F enrichment tubes. At weeks 3 and 4, the Selenite-F tubes showed heavy growth whereas the PSB tubes yielded moderate growth. By week 4 the plates from the Selenite-F enrichment tubes had a lot of large mucoid type colonies covering the plate. The PSB broth plates did not have these large mucoid colonies. At weeks 3 and 4, Yersinia-type colonies were observed on plates from both enrichment broths; however the colonies from the Selenite-F broth were not well isolated due to the large mucoid colonies. Colonies from the PSB tubes were isolated fairly well. As a result of this observation, it was decided to use PSB as the enrichment medium.

YSA was reported by far to be the best primary isolation medium (Head, et al, 1982). One report indicated that a new medium, BABY-4, was very good for isolating Yersinia from environmental type samples (Bercovier, et al, 1984) . An experiment was set up to compare YSA and BABY-4. Dewatered primary sludge was used and PSB was the enrichment medium. The procedure for BABY-4 was to incubate one day anaerobically followed by two days aerobically at 26 degrees C. The procedure recommended for YSA is 2 days aerobically at 26 degrees C. Using the enrichment procedure established previously, a 3 tube MPN was set up. At the end of each week, the first 2 rows of the enrichment tubes were streaked to YSA and BABY-4. After the recommended incubation period for both plating media, it was evident that BABY-4 was not as good a differential medium as YSA. On BABY-4 there were many

Yersinia-type colonies that did not confirm, whereas on YSA, *Yersinia* were more distinctive. When BABY-4 was incubated without the anaerobic step, the plates were overgrown with other bacteria and no *Yersinia* were evident.

Incubation of the enrichment tubes was originally established at 1 to 4 weeks at 4 C. At the end of each week the enrichment tubes were plated on the primary isolation medium. Early in the study it was determined that *Yersinia* were never isolated during the first two weeks of incubation; plating was subsequently only performed at the end of weeks 3 and 4.

The manufacturer of *Yersinia* Selective Agar states to incubate their medium for 48 hours at 25 C. With compost samples better isolation was achieved after 24 hours. The *Yersinia* colonies were small but were easier to differentiate from other background bacteria.

Finally, recovery experiments were conducted using the PSB enrichment at 4 C and YSA as the selective isolation medium. Results are listed in Table A-3. Average recovery was 110% and ranged from 40% to 175%.

TABLE A-3 VERSINIA RECOVERY OF SEEDED ORGANISMS FROM COMPOST

	Control Replicates MPN/100mL				Spike	Recovery Replicates MPN/100mL				%
Sample	1	2	3	Geo. Mean	CFU/100ml	1	2	3	Geo. Mean	Recovery
A	4	4	<1	<3	690	150	930	150	280	40
B	1	4	4	3	120	93	430	230	210	175
C	<1	<1	<1	<1	210	430	93	930	330	157
D	<1	<1	<1	<1	930	930	930	390	700	75
E	<1	<1	<1	<1	56	93	43	43	56	100

[a] Unspiked samples

GIARDIA CYSTS AND *ASCARIS* OVA

The parasite ova procedures used for this study were essentially the same as those used and documented by other researchers for sludge samples i.e., a zinc sulfate density gradient separation followed by an acid-alcohol/ether sedimentation. Recovery experiments were conducted using seeded *Ascaris* ova and are reported in Table A-4. Average recovery of seeded ova was 88% and ranged from 83% to 92%.

Since the same procedure was going to be used for cysts, recovery experiments were also conducted with preserved *Giardia muris* cysts.

Initial experiments examined methods for enumerating the cysts. The Sedgewick Rafter cell used for helminth ova was not satisfactory due to the small size of the cysts and the inability to use high power objectives with a Sedgewick Rafter cell. A hemocytometer was found adequate for counting cysts, as a fairly large number of cysts was present.

An experiment was then set up to determine the recovery of *Giardia* cysts from compost. A ten percent suspension of compost (350 mL) was seeded with 2.0×10^{5} *G. muris* cysts. The sample was processed by the procedure used for *Ascaris* ova. The final concentrate volume was 1 mL. One tenth milliliter was counted yielding a recovery of less than one percent. Counting cysts proved to be quite difficult.

A second experiment was designed to test the presence or absence of cysts in seeded compost containing decimal dilutions of cysts. Four 200 mL aliquots of ten percent compost suspension were seeded respectively with 12,500 cysts/gdw. After processing and concentrating the seeded samples by the procedure used for *Ascaris* ova, portions of the final concentrate were fixed to microscope slides, stained with trichrome stain and examined microscopically. The trichrome stain made it much easier to see the cysts in the presence of other micro-particulates that end up in the concentrate. Nevertheless, detectability was still quite poor. Cysts were detected from the 1,250 cysts/gdw sample but not from the lower concentration samples.

It was obvious at this point that the separation/concentration procedure used for helminth ova was not effective for *Giardia* cysts. Another experiment was conducted to determine where the cysts were lost during the concentration procedure. The first step of the ova procedure was to blend the compost sample with phosphate buffered dilution water containing a wetting agent/dispersant (Tween 80) and wash the suspension through a 48 mesh sieve. The resulting washed suspension was allowed to settle overnight during which time the ova settled to the bottom. This step was examined using Giardia cysts. A compost sample was seeded with 2 X 10^6 cysts and processed as usual. After overnight settling (approximately 18 hours) the supernatant was siphon decanted and saved. Both the sediment and the supernate were centrifuged and resuspended in zinc sulfate. The resulting concentrates were then titered. The supernate contained 1.3 X 10^6 cysts (65%) and the sediment contained 1.8 X 10^5 cysts (9%). Twenty-six percent of the cysts were lost or unaccounted for due to anaytical error. This experiment demonstrated that a majority of the cysts did not settle out overnight and were lost when the supernatant was discarded.

The method for detecting helminth ova was shown to be an effective procedure for ova. It appeared to be relatively ineffective for cysts. Alternate techniques for detecting cysts that circumvent the gravity settling step were evaluated. One approach that was discussed and showed some promise was to take a 100 mL aliquot from the blended sample and centrifuge it directly before zinc sulfate flotation. A presence/absence test was set up using this approach. Four compost suspensions were seeded with cysts at concentrations of 8,300 cysts gdw, 830 cysts/gdw, 83 cysts/gdw, and 8.3 cysts/gdw respectively. One hundred milliliter grab samples were taken directly from each blender jar and centrifuged. The resulting pellet was resuspended in zinc sulfate and the surface layer was collected by skimming with a pasteur pipet. Resulting concentrates were fixed to slides, trichrome stained and examined microscopically. The large particulates usually removed by the sieve interfered with the microscopic observation. In spite of this difficulty, cysts were detected at the 83 cysts/gdw concentration but not at the 8.3 cysts/gdw level.

Although these data represented a significant improvement in detectability of cysts, the detection limit still appeared to be relatively high. A truly efficient method of recovering Giardia cysts from compost was not available for this project.

Table A-4. *Ascaris* Ova Recovery of Seeded Ova From Compost Suspension

Sample	Ova/mL		%Recovery
	Seed	Recovered	
A	40	34	85
B	47	43	91
C	58	49	84
D	66	57	86
E	25	23	92

COMPARISON OF BGMK AND MA104 CELLS

The sensitivity of Buffalo Green Monkey Kidney (BGMK) and Embryonic Rhesus Monkey Kidney (MA104) cells were compared for enumerating enteric viruses in sewage and sludge samples. The BGMK cell line was obtained from Dr. T.G. Metcalf in 1979. Several clones of BGMK had been evaluated in Metcalf's laboratory and this clone had been determined to be the most sensitive for detecting enteric viruses (T.G. Metcalf, personal communication). BGMK cells were used until reaching passage 175 and then replaced with lower passage cells from frozen stock. MA104 cells were obtained at passage 64 in May 1985 from Montgomery Laboratories, Pasadena, California.

Each cell line was simultaneously inoculated with concentrates from wastewater and anaerobically digested sludge. Cell cultures were maintained and samples were concentrated and assayed as previously described (Glass _et al_ 1978). Nineteen wastewater samples and twelve sludge samples were tested. In addition four stock enteric virus suspensions (Polio 1, ECHO 1, ECHO 7 and Coxsackie B6) were titered on both cell lines. The plaques counted on each cell line were totaled for the wastewater and sludge samples; stock virus titers were calculated and expressed as PFU/mL. Results are shown in Table A5.

Table A5 BGMK - MA104 Comparison

		Plaque Forming Units[a]	
Sample	n	BGMK	MA104
Wastewater	19	306	142
Sludge	12	515	310
Polio 1	1	7.0×10^6	9.5×10^6
ECHO 1	1	2.3×10^5	1.1×10^5
ECHO 7	1	1.9×10^6	1.4×10^6
Coxsackie B6	1	1.6×10^7	7.0×10^5

(a) Total number of PFU for wastewater and sludge samples and PFU/mL for stock viruses.

The BGMK cell line produced approximately twice as many plaques as the MA104 cells from the wastewater and sludge samples. The BGMK cells also produced higher titers for the ECHO viruses and the Coxsackie virus. The Coxsackie virus titer was more than an order of magnitude higher on the BGMK cells. The MA104 cells produced a slightly higher titer for the polio 1 stock. Overall, the BGMK cell line was more sensitive than the MA104 cells. BGMK was selected for assaying sludge and compost samples during this study.

APPENDIX B

MICROBIOLOGICAL QUALITY ASSURANCE

MICROBIOLOGICAL QUALITY ASSURANCE

GENERAL PROCEDURES

Microbiological quality assurance practices for this project consisted of three main components. First, standard microbiology laboratory quality assurance procedures, as described in Standard Methods (APHA, 1985) and the EPA Manual, Microbiological Methods for Monitoring the Environment (EPA, 1978), such as recording incubator and water bath temperatures daily and maintaining media preparation and sterilization records, were followed. Second, ten percent of the project samples were run in duplicate. Precision criteria were calculated from fifteen duplicate samples as described in Standard Methods (APHA, 1985). The differences between sample duplicates were compared to the precision criteria to indicate possible analytical problems. The final aspect of the quality assurance program involved "blind spiking" of a portion of the duplicate samples.

Routine Quality Assurance

Routine QA practices indicated there were not any undetected equipment, media or reagent problems during the course of the project that would have affected the reliability of the microbiological data.

Duplicate Analyses

Ten percent of the samples were run in duplicate and compared to pre-established precision criteria. The initial precision criteria were calculated from compost samples collected from a single source and therefore were not entirely representative of all samples tested during the study. The precision criteria were later recalculated with data from fifteen randomly selected project duplicates representing all sample types and compared to the initial values. These results are shown in Table B-1.

Table B-1 Comparison of Initial and Recalculated Precision Criteria

TEST	INITIAL		RECALCULATED	
	Criterion Value	Number[a] Pass/Fail	Criterion Value	Number Pass/Fail
Total Coliform	0.9414	38/2	1.1988	39/1
Fecal Coliform	1.1121	34/1	1.1288	34/1
Fecal Streptococci	1.0722	42/3	1.6722	44/1
Plate Count-Aerobic	0.2492	31/1	0.3812	32/0
Plate Count-Anaerobic	0.1799	26/6	0.6452	30/2
Total Fungi	b	--	0.7161	16/3
Thermophilic Fungi	b	--	0.5957	18/1
Total Enteric Bacteria	0.6219	34/0	0.4376	34/0
Salmonella	1.5210	13/1	1.1315	13/1
Yersinia	1.1462	3/0	c	--
Total Parasites	0.6674	28/0	0.5702	27/1
Ascaris	0.9192	15/0	0.7296	14/1
Bacteriophage	0.6949	13/4	1.2669	17/0

[a] The numerator plus the donominator represent 10% of all tests performed in that category where positive results were obtained.

[b] Not determined initially.

[c] Not enough positive samples to recalculate.

It can be seen that the precision criteria generally reflected a greater spread of data using the actual project samples compared to initial criteria values derived from a single source prior to the beginning of the sampling program. Exceptions were the total enteric bacteria, Salmonella, total parasites and the Ascaris tests. Initial values were not calculated for the fungal tests. Any time a duplicate failed to fall within the established criterion, analytical techniques and general QA data were reviewed. No systematic errors were detected to explain the cases of excess variation.

Overall, precision was acceptable. The cases of excess variation ranged from 3.8 percent to 6.5 percent of the duplicates depending on which set of criterion values was used. Inherent characteristics of two of the tests explained a major portion of the variation. The anaerobic plate counts occasionally contained large spreading colonies. One or two of these colonies often obscured many smaller colonies. The presence of these colonies frequently resulted in excess variation between duplicates. A similar situation occurred with the fungi. Certain species of fungi obscured an entire plate. If the anaerobic plate count and fungal variation is discounted, unexplained excess variation occurred in slightly less than two percent of the duplicates.

The total number of duplicate analyses shown in Table B-1 were different for the various tests. Samples that were negative were not included in the comparison resulting in notably fewer duplicates for the pathogens. Also, duplicates that were seeded with blind spikes were affected by the spike and were not included in the precision evaluation.

Blind Spikes

A screw cap culture tube containing approximately 5 mL of sterile compost suspension was supplied to the laboratory and added to the duplicate sample suspension in the second blender jar. Occasionally, the tube contained a microorganism spike. Staff did not know which tubes were seeded. Spikes were added at estimated concentrations ranging from approximately 1000 to 100,000 units/mL. Concentrations were estimated from pretitered stock suspensions for parasites and viruses and by dilution procedures for the bacteria (Standard Methods, APHA 1985, p 836). Spikes were not titered separately. Recovery was reported as plus or minus.

Spike recoveries are listed in Table B-2. Salmonellae, Yersinia, Ascaris ova, polio virus and Coxsackie virus were detected each time they were spiked. Campylobacter was detected in three of five spikes, toxigenic E. coli was detected in two of four samples, Giardia cysts were detected in three of eight spikes and ECHO virus was detected in one of two spiked samples.

Based on preliminary recovery studies or previous experimentation in the laboratory, the blind spike recoveries followed expected patterns. The Campylobacter and Giardia cyst procedures were known to be low sensitivity tests. Quantitative recovery experiments were not conducted for the toxigenic *E. coli*; however, it would be expected that recovery would be related to the ratio of toxigenic strains to non-toxigenic *E. coli*. The greater that ratio, the less likely it would be that a toxigenic strain would be picked for subsequent testing.

The missed ECHO virus seed was unexpected. The first ECHO seed was detected but the second was not. It is possible that the frozen virus stock used for seeding had lost infectivity. The ECHO II stock was retitered a month before and five months after the missed seed. Infective viruses were detected in the earlier retitering of the stock but not in the latter.

Table B-2 Detection of Blind Spikes

Organism	Number of Spikes Detected	Number of Spikes Not Detected
Salmonella sp	2	0
Salmonella typhi	1	0
Yersinia enterocolitica	6	0
Campylobacter jejuni	3	2
Shigella soneii	0	1
Toxigenic *E. coli*	2	2
Ascaris ova	6	0
Giardia Cysts	3	5
ECHO II virus	1	1[a]
Polio I virus	2	0
Coxsackie B4 virus	2	0

[a] Seed stock may have been dead

Quality Assurance Summary

A general summary of the analytical parameters for tests used during this study are summarized in Table B-3. Certain aspects of the microbiological quality assurance presented definite problems. Duplicate precision was inherently difficult with some of the plating tests, particularly the anaerobic plate count and the fungal tests. The problems associated with large spreading bacterial colonies and the growth characteristics of a few fungi clearly interfered with the use of standard quantitative precision comparisons.

Table B-3. Analytical Parameters Associated with Microbiological Tests Used for Occurrence of Pathogens Project

Test	Calculated Detection Limit[a]	Recovery of Seeded Organisms (%)
Total Coliform	0.5 MPN/g	ND[b]
Fecal Coliform	0.5 MPN/g	ND
Fecal Streptococci	0.5 MPN/g	ND
Aerobic Plate Count	170 CFU/g	NA[c]
Anaerobic Plate Count	170 CFU/g	NA
Total Fungi	33 CFU/g	NA
Thermophilic Fungi	33 CFU/g	NA
Bacteriophage	17 PFU/g	ND
Enteropathogenic *E. Coli*	0.7 MPN/g	ND
Total Enteric Plate Count	170 CFU/g	NA
Salmonella	0.2 MPN/g	105
Campylobacter	1000 CFU/g[g]	<1
Yersinia	0.5 MPN/g	109
Parasites (Ova)	0.2 OVA/g	88[d]
Parasites (Cysts)	NA	<1[e]
Enteric Viruses	0.05 IU/g	30[f]

[a] Based on average 60% TS; individual samples may vary.
[b] Not determined.
[c] Not applicable.
[d] *Ascaris* ova.
[e] *Giardia* cysts.
[f] *Glass et al* 1978.
[g] Estimated from recovery experiments.

These difficulties, however, were probably compensated for by the size of the data base collected for this study.

The large range of the observed data also made the blind seeding experiments difficult to conduct and evaluate. This was readily seen with the toxigenic E. coli. If a seed concentration of 10,000 - 100,000 toxigenic E. coli was introduced into a sample containing a low density of fecal coliforms, the seed essentially swamped the population and all that was measured was essentially the seed organism. On the other hand, if the fecal coliforms were at a concentration of eight to nine orders of magnitude, the seed might represent less than one percent of the population.

The use of virus seeds also resulted in apparent contamination problems. The laboratory usually segregated seeding experiments from actual sample testing. That practice was not followed for the blind seeds and a low level of contamination occurred. The pH electrode used during sample processing was suspected as the source of the sample to sample contamination but that was not definitively established. This writer would not recommend the use of blind virus seeds for environmental monitoring studies. Similar sample types containing low indigenous virus populations, such as raw sludges for this project, could be used as positive controls for the virus methods and alleviate the problems associated with working concurrently with seed stocks and negative samples.

APPENDIX C

MICROBIOLOGICAL DATA

TABLE C1 SITE: III-B-1 STATIC PILE COMPOST - GIVEAWAY BIN

* * * * * * * * * * * * * * * * * * SAMPLE TEST RESULTS * * * * * * * * * * * * * * * *

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
01/23/86	SJ20646	84.0	6.044	4.709	3.709	9.510	8.632	3.984	4.062
01/27/86	SJ20817	79.9	3.066	3.066	3.066	8.545	8.394	4.649	4.098
02/06/86	SJ21051	78.3	3.739 B	1.604 B	3.327 B	7.783 B	7.268 B	3.931 B	> 4.708 J
02/10/86	SJ21180	46.2	8.658	8.414	7.697	9.739	8.585	5.135	4.745
02/24/86	SJ21421	47.9	5.681	5.288	5.496	8.461	7.083	5.182	5.122
03/05/86	SJ21604	60.4	6.581	4.852	4.187	9.626	8.447	5.143	4.862
03/10/86	SJ21787	43.0	8.000	7.000	7.543	9.718	9.091	4.753	4.743
03/17/86	SJ21934	55.9 B	8.758 B	7.614 B	6.398 B	9.860 B	9.148 B	5.278 B	5.553 B
03/24/86	SJ22183	44.3	7.987	6.987	7.322	10.180	10.074	5.701	5.015
03/31/86	SJ22830	57.4	6.417	5.116	6.875	9.405	8.869	3.355	3.411
04/07/86	SJ22608	41.6	7.014	5.256	7.014	9.758	7.893	4.550	4.312
04/15/86	SJ22931	52.7	7.640	6.912	7.247	9.886	9.563	5.056	5.744
04/22/86	SJ23131	44.9	7.316	6.316	6.981	9.725	7.527	5.649	5.527
04/29/86	SJ23310	44.9	5.709	4.709	6.981	9.887	9.557	2.578	2.795
05/05/86	SJ23579	53.1	6.451	6.451	6.637	9.697	7.531	4.222	3.339
05/12/86	SJ23708	61.4 B	5.709 B	5.481 B	6.013 B	8.750	6.893	4.350	4.134
05/19/86	SJ23837	65.3	3.819	3.547	6.361	7.531	6.704	3.154	3.154
06/03/86	SJ24103	59.1	5.591	2.863	4.204	8.991 D	8.204 D	2.000	2.301
06/10/86	SJ24277	71.9	7.018	6.505	6.185	9.206	8.782	5.279	5.987
06/17/86	SJ24504	60.9	7.184	7.184	6.184	9.362	7.213	3.079	3.845
06/23/86	SJ24678	70.5	5.514 D	3.785 D	4.785	9.101	6.532	5.000	3.204
06/30/86	SJ24828	66.6	5.353	4.499	4.810	8.511	6.745	4.079	4.146
07/22/86	SJ25337	69.4	8.127 D	7.335 D	5.335	9.512	8.519	> 6.000	> 6.000
07/29/86	SJ25576	62.4	7.173	7.173	6.173	9.644	9.062	4.462	4.568
08/04/86	SJ25798	58.8	5.864	5.864	5.864	9.508	6.912	4.851	5.176
08/12/86	SJ25995	66.1	6.813 B	6.813 B	6.066 B	9.128 B	8.404 B	6.462 B	6.505 B
08/19/86	SJ26172	65.4	8.146	8.146	7.845	9.415	7.851	6.041	6.531
08/27/86	SJ26350	66.5	6.544 D	6.146 D	5.813	9.342	7.322	6.176	5.230
09/02/86	SJ26588	69.9	4.792	4.519	4.477	9.079	6.519	5.505	5.531
09/08/86	SJ26683	79.8 D	5.462	3.462	5.462	9.279	8.041	5.255	6.176
09/16/86	SJ26959	88.0	7.041	7.041	5.690	10.079	9.591	6.398	6.491
09/22/86	SJ27108	73.3	5.771 D	4.771 D	4.771 D	8.663	6.869	5.756	5.716
09/29/86	SJ27469	59.7	6.544	5.857	4.857	7.519	6.699	5.785	4.255
10/06/86	SJ27450	70.4	8.519	5.785	6.519	9.431	8.204	6.892	6.146
10/14/86	SJ27752	68.1	6.146	6.146	5.799	9.792	7.505	6.643	5.908
10/20/86	SJ27947	74.0	7.301	6.114	6.763	9.362	7.813	7.447	7.763
10/27/86	SJ28166	73.1	5.519 D	2.491 D	4.519 D	8.342	7.763	5.146	6.146
11/03/86	SJ28413	60.5	7.398	7.176	7.851	10.431	8.462	5.279	5.176
11/10/86	SJ28482	77.8	5.827 B,D	3.841 B,D	4.079 B,D	8.834 B	7.212 B	5.230 B	5.255 B
11/24/86	SJ29030	84.1	4.431	2.431	2.041	7.978	7.279	4.279	4.462

TABLE C1 CONT'D. SITE: III-B-1 STATIC PILE COMPOST - GIVEAWAY BIN

* S A M P L E T E S T R E S U L T S * * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
12/01/86	SJ29378	62.4	6.380	4.839	6.176	9.362 D	7.653 D	7.462	7.204
12/08/86	SJ29389	89.5	3.114 D	1.681 D	3.230	7.505	6.342	> 6.568	> 6.690
12/23/86	SJ29590	85.1	5.041	5.041	3.708	8.362 D	7.708 D	5.708	6.041
12/30/86	SJ30403	83.7	2.431 D	1.398 D	1.255 D	7.875	6.908	4.146	5.342
01/06/87	SJ30412	84.0	3.255	3.041	2.041	7.580	6.663	4.415	3.477
01/12/87	SJ30491	85.9	3.041	2.041	1.699	8.230	6.301	5.342	5.991
01/20/87	SJ30658	84.3	5.708	5.041	3.949	8.978	7.898	5.881	5.602
01/27/87	SJ31371	86.5	3.230	1.699	1.431	7.041	6.672	4.919	4.643

TABLE C1 CONT'D. SITE: III-B-1 STATIC PILE COMPOST - GIVEAWAY BIN

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	YERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
01/23/86	SJ20646	< 1.076	< .5	7.465	1.9	< 1	< .1	< .1	< .1
01/27/86	SJ20817	< 1.097	< .5	6.328	< .1	< 1	< .1	.5	< .1
02/06/86	SJ21051	< 1.106	< .5	6.992 B	< .1 B	< 1 B	< .1 B	1.1	.8
02/10/86	SJ21180	1.937	< .9	9.056	< .2	< 1	3.2	2.5	2.0
02/24/86	SJ21421	2.621	< .8	7.682	.8	< 1	61	1.2	.3
03/05/86	SJ21604	< 1.219	< .7	9.011	< .2	< 1	35	.9	.8
03/10/86	SJ21787	3.321	< .9	8.588	100	< 1	2	.2	< .2
03/17/86	SJ21934	3.545 B	< .7 B	9.107 B	< .2 B	< 1	25 B	.5	.1
03/24/86	SJ22183	2.580	< .9	9.416	5.2	< 1	54000000 D	.5	.2
03/31/86	SJ22830	< 1.230	< .7	8.210	< .2	< 1	3.7	.3	< .1
04/07/86	SJ22608	1.982	< 1	9.004	550	< 1	1500	.4	< .2
04/15/86	SJ22931	4.431	< .8	9.064	44	< 1	8700	.5	.4
04/22/86	SJ23131	5.903	< .9	9.024	< .2	< 1	24000	.6	.3
04/29/86	SJ23310	3.204	< .9	9.234	.2	< 1	510 D	.7	.2
05/05/86	SJ23579	3.279	< .8	9.060	8700	< 1	280	.4	.1
05/12/86	SJ23708	1.689 B	< .7	7.591	< .2	< 1	< .5 B	.1 B	.07 B
05/19/86	SJ23837	< 1.176	< .6	6.018	< .2	< 1	< .2	< .1	< .1
06/03/86	SJ24103	< 1.301	< .7	8.146	< .2	< 1	< .2	.4	.4
06/10/86	SJ24277	3.279	< .6	8.620	6.0	< 1	< .1	< .1	< .1
06/17/86	SJ24504	3.690	.7	8.307	38	< 1	< .2	< .1	< .1
06/23/86	SJ24678	< 1.000	< .6	8.226	< .1	< 1	< .1	< .1	< .1
06/30/86	SJ24828	< 1.301	< .6	7.501	< .2	< 1	< .2	.1	< .1
07/22/86	SJ25337	5.431	< .6	8.883	33	< 1	< .1	< .1	< .1
07/29/86	SJ25576	< 1.301	< .6	8.972	690	< 1	< .2	.1	< .1
08/04/86	SJ25798	< 1.301	< .7	7.389	< .2	< 1	< .2	.8	< .1
08/12/86	SJ25995	1.452 B	< .6 B	8.267 B	150 B	< 1 B	< .2 B	.16	< .05
08/19/86	SJ26172	4.301	< .6	8.462	660	< 1	< .2	< .2	< .2
08/27/86	SJ26350	4.462	< .6	8.279	.2	< 1	< .2	< .09	< .09
09/02/86	SJ26588	3.491	< .6	7.716	.1	< 1	< .1	< .1	< .1
09/08/86	SJ26683	< 1.000	< .5	8.362	< .1	< 1	< .1	< .09	< .09
09/16/86	SJ26959	3.000	< .4	8.447	170	< 1	< .1	< .06	< .06
09/22/86	SJ27108	2.204	< .6	7.556	1	< 1	< .1	< .1	< .1
09/29/86	SJ27469	1.699	< .7	6.929	390	< 1	< .2	< .1	< .1
10/06/86	SJ27450	2.973	< .6	8.763	330	< 1	< .1	.1	< .1
10/14/86	SJ27752	< 1.000	< .6	8.924	< .1	< 1	< .1	< .1	< .1
10/20/86	SJ27947	4.079	< .5	8.079	< .1	< 1	< .1	< .1	< .1
10/27/86	SJ28166	< 1.000 D	.6	6.964	< .1	< 1	< .1	< .1	< .1
11/03/86	SJ28413	3.076	< .7	9.342	3800	< 1	< .2	< .09	< .09
11/10/86	SJ28482	< 1.000 D	< .5 B	7.987 B	< .1 B	< 1 B	< .1 B	.06 B	< .04 B
11/24/86	SJ29030	< 1.000 D	.5 D	6.279 D	< .1	< 1	< .1	< .07	< .07

TABLE C1 CONT'D. SITE: III-B-1 STATIC PILE COMPOST - GIVEAWAY BIN

SAMPLE TEST RESULTS

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	VERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
12/01/86	SJ29378	1.477 D	< .6 D	8.415	.5	< 1	3.4	.18	.09
12/08/86	SJ29389	< 1.000 D	< .4	6.929 D	< .1	< 1	< .1	.2	.2
12/23/86	SJ29590	< 1.000	< .5	6.892	1	< 1	< .1	.2	.2
12/30/86	SJ30403	< 1.000 D	< .5	5.903	< .1	< 1	< .1	< .09	< .09
01/06/87	SJ30412	< 1.301	< .5	5.591	< .1	< 1	< .1	< .09	< .09
01/12/87	SJ30491	< 1.000	< .5	6.690	< .1	< 1	< .1	< .09	< .09
01/20/87	SJ30658	< 1.000 D	< .5	7.724	< .1	< 1	< .1	< .09	< .09
01/27/87	SJ31371	< 1.000	< .5	5.820	< .1	< 1	< .1	< .09	< .09

TABLE C1 CONT'D. SITE: III-B-1 STATIC PILE COMPOST - GIVEAWAY BIN

* SAMPLE TEST RESULTS *

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
01/23/86	SJ20646	< .1	< .1	< .1	< .1	< .03
01/27/86	SJ20817	< .1	.5	< .1	< .1	< .03
02/06/86	SJ21051	< .1	.3	< .1	< .1	< .03
02/10/86	SJ21180	< .2	.5	< .2	< .2	< .05
02/24/86	SJ21421	< .2	.8	< .2	< .2	< .05
03/05/86	SJ21604	< .1	.1	< .1	< .1	< .04
03/10/86	SJ21787	< .2	.2	< .2	< .2	< .06
03/17/86	SJ21934	< .1	.4	< .1	< .1	< .06
03/24/86	SJ22183	< .2	.4	< .2	< .2	< .08
03/31/86	SJ22830	< .1	.1	< .1	< .1	< .06
04/07/86	SJ22608	< .2	.4	< .2	< .2	< .08
04/15/86	SJ22931	< .1	.1	< .1	< .1	< .07
04/22/86	SJ23131	< .2	.3	< .2	< .2	< .08
04/29/86	SJ23310	< .2	.5	< .2	< .2	> .09
05/05/86	SJ23579	< .1	.3	< .1	< .1	< .07
05/12/86	SJ23708	< .1 B	.07 B	< .1 B	< .1 B	< .06
05/19/86	SJ23837	< .1	< .1	< .1	< .1	< .05
06/03/86	SJ24103	< .1	< .1	< .1	< .1	< .05
06/10/86	SJ24277	< .1	< .1	< .1	< .1	< .05
06/17/86	SJ24504	< .1	< .1	< .1	< .1	< .06
06/23/86	SJ24678	< .1	< .1	< .1	< .1	< .05
06/30/86	SJ24828	< .1	.1	< .1	< .1	< .06
07/22/86	SJ25337	< .1	< .1	< .1	< .1	< .05
07/29/86	SJ25576	< .1	.1	< .1	< .1	< .06
08/04/86	SJ25798	< .1	.5	< .1	.3	< .06
08/12/86	SJ25995	< .05	.08	.08	< .05	< .06
08/19/86	SJ26172	< .2	< .2	< .2	< .2	< .06
08/27/86	SJ26350	< .09	< .09	< .09	< .09	< .06
09/02/86	SJ26588	< .1	< .1	< .1	< .1	< .06
09/08/86	SJ26683	< .09	< .09	< .09	< .09	< .05
09/16/86	SJ26959	< .06	< .06	< .06	< .06	< .04
09/22/86	SJ27108	< .1	< .1	< .1	< .1	< .05
09/29/86	SJ27469	< .1	< .1	< .1	< .1	< .06
10/06/86	SJ27450	< .1	< .1	< .1	.1	> .06 A
10/14/86	SJ27752	< .1	< .1	< .1	< .1	< .05
10/20/86	SJ27947	< .1	< .1	< .1	< .1	< .05
10/27/86	SJ28166	< .1	< .1	< .1	< .1	< .06
11/03/86	SJ28413	< .09	< .09	< .09	< .09	< .06
11/10/86	SJ28482	< .04 B	.06 B	< .04 B	< .04 B	< .05
11/24/86	SJ29030	< .07	< .07	< .07	< .07	< .04

TABLE C1 CONT'D. SITE: III-B-1 STATIC PILE COMPOST - GIVEAWAY BIN

SAMPLE TEST RESULTS

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
12/01/86	SJ29378	< .09	.09	< .09	< .09	< .06
12/08/86	SJ29389	< .08	< .08	< .08	< .08	< .04
12/23/86	SJ29590	< .09	< .09	< .09	< .09	< .05
12/30/86	SJ30403	< .09	< .09	< .09	< .09	< .04
01/06/87	SJ30412	< .09	< .09	< .09	< .09	< .04
01/12/87	SJ30491	< .09	< .09	< .09	< .09	< .04
01/20/87	SJ30658	< .09	< .09	< .09	< .09	< .04
01/27/87	SJ31371	< .09	< .09	< .09	< .09	< .05

FOOTNOTE(S) :

A - POSSIBLE CONTAMINATION BY SPIKE
B - AVERAGE OF DUPS
D - RETESTED
J - INTERFERENCE

TABLE C2 SITE: III-B-2 STATIC PILE COMPOST - SCREENED

* S A M P L E T E S T R E S U L T S *

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
01/23/86	SJ20647	57.7	8.207	7.601	7.207	9.857	9.619	5.716	6.063
01/27/86	SJ20818	47.3	7.294	6.959	7.687	9.933	9.200	5.626	6.056
03/05/86	SJ21605	60.3	8.600	8.188	6.581	9.550	8.413	> 5.164	> 6.060
03/10/86	SJ21788	59.1	9.380	8.634	7.197	9.841	8.499	5.571	5.609
03/17/86	SJ21935	52.7	7.183	6.912	7.454	9.917	9.272	5.730	5.666
03/24/86	SJ22184	56.2 B	7.884	6.713	6.415 B	9.658	9.076	5.431	5.342
03/31/86	SJ22831	58.2	7.597	7.204	6.204	9.613	7.843	4.680	4.636
04/07/86	SJ22609	50.3	7.475	6.761	6.932	10.031	8.148	4.718	4.903
04/15/86	SJ22932	51.9	8.665	7.918	7.918	10.201	8.482	3.761	4.985
04/22/86	SJ23132	59.7	6.586	5.857	6.193	9.722	8.312	3.932	4.335
04/29/86	SJ23311	47.5	3.957	3.957	3.527	7.861	7.726	2.842	4.277
05/05/86	SJ23580	56.6	7.609 D	7.609 D	7.122 D	9.472	8.860	5.816	3.724
05/12/86	SJ23709	62.1	5.569	5.569	5.569	9.551	6.935	4.282	4.377
05/19/86	SJ23838	54.5 B	5.065 B	4.897 B	5.429 B	9.193 B	8.984 B	2.673 B	2.507 B
06/03/86	SJ24104	76.5	2.707 D	1.478 D	5.085	9.053	7.019	2.633	3.820
06/10/86	SJ24278	67.0	5.807	5.807	6.536	9.288 D	8.993 D	4.505	4.462
06/17/86	SJ24505	60.4	4.852	4.852	7.167	9.382	9.091	2.881	3.748
06/23/86	SJ24679	80.7	4.727	4.727	6.062	9.304	8.956	5.857	5.968
06/30/86	SJ24829	68.4	6.341	5.527	6.527	9.715	9.097	3.991	3.398
07/22/86	SJ25338	64.7	5.158 D	5.158 D	5.365	9.227	8.061	4.591	5.724
07/29/86	SJ25577	65.7	6.505	6.146	7.146	9.724	8.869	4.881	4.851
08/04/86	SJ25797	68.3	6.527	5.799	7.134	9.330	8.542	4.672	4.114
08/12/86	SJ25996	61.4	6.574	5.845	7.388	9.497	8.590	4.591	4.398
08/19/86	SJ26173	61.0	7.875	7.875	8.875	9.613	8.903	< 1.000	3.724
08/27/86	SJ26351	65.5	6.293 B	5.962 B	7.537 B	8.929	8.079	< 1.000 B	4.623 B
09/02/86	SJ26589	65.0	6.820	6.146	7.146	8.079	7.580	< 1.000	4.041
09/08/86	SJ26684	64.7	7.505	6.820	8.146	9.886	8.415	> 5.663	> 5.663
09/16/86	SJ26960	73.5	6.771	6.771	7.000	9.806	8.146	5.800	6.477
09/22/86	SJ27109	72.0	7.505 D	6.342 D	6.322 D	9.708	7.708	5.491	5.255
10/29/86	SJ27470	59.7	6.857	6.591	6.591	9.255	7.785	4.602	< 1.000
10/06/86	SJ27451	63.6	7.833	7.833	8.176	8.806	8.431	< 1.000	4.531
10/14/86	SJ27753	58.7	5.591	5.591	7.863	8.778	8.447	< 1.000	4.591
10/20/86	SJ27948	58.8	8.613	7.863	6.591 D	9.491 D	9.041 D	3.771	4.398
10/27/86	SJ28167	59.6	6.591	6.591	8.114	9.041	8.591	2.462	4.699
11/03/86	SJ28414	60.8	7.851	7.851	8.580	9.934	8.447	4.462	4.519
11/10/86	SJ28483	56.3	8.230	8.230	7.613	10.230	9.505	5.176	4.996
11/24/86	SJ29031	56.2	7.886	7.431	6.613	10.114	9.613	4.041	4.748
12/01/86	SJ29379	57.3	8.602	8.602	7.875	9.914 D	8.342 D	4.845	4.987
12/08/86	SJ29390	54.4	8.885 B,D	7.064 B,D	7.260 B,D	9.605 B	9.073 B	5.544 B	5.431 B
12/23/86	SJ29591	53.6	8.903	8.903	7.903	10.230	9.279	5.643	5.041
12/30/86	SJ30404	47.8	6.954	5.954	6.279	10.079	8.041	5.114	4.949
01/06/87	SJ30413	47.8 B	5.643 D	4.954 D	5.954 D	9.908	9.322	< 1.000	4.580
01/12/87	SJ30492	49.5	7.968	7.279	6.898	10.041	8.204	4.954	5.041
01/20/87	SJ30659	41.0 B	6.748	4.748	5.362	9.568	9.114	4.633	5.580
01/27/87	SJ31372	44.8	5.708	4.708	5.708	9.653	8.845	4.230	4.301

TABLE C2 CONT'D. SITE: III-B-2 STATIC PILE COMPOST - SCREENED

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	VERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
01/23/86	SJ20647	5.217	< .7	9.280	75	< 1	4.3	.6	.5
01/27/86	SJ20818	2.817	< .9	9.388	9	< 1	18000	.2	< .2
03/05/86	SJ21605	4.233	< .7	8.892	380	< 1	35	.5	.2
03/10/86	SJ21788	5.086	< .7	9.126	25	< 1	2500000 D	1.5	1.0
03/17/86	SJ21935	4.716 B	< .8	9.247	1.0	< 1	820000 D	.1	< .1
03/24/86	SJ22184	3.305 B	< .7 B	8.807	.7 B	< 1 B	27000 D	.3	.1
03/31/86	SJ22831	2.653	< .7	8.458	< .2	< 1	400	.6	.4
04/07/86	SJ22609	4.322	< .8	9.039	42	< 1	460000 D	.4	.3
04/15/86	SJ22932	3.415	< .8	9.188	< .2	< 1	8900	.3	.3
04/22/86	SJ23132	5.176	< .7	8.636	< .2	< 1	40000	.8	.4
04/29/86	SJ23311	1.322	< .8	6.133	< .2	< 1	< .6	.5	.3
05/05/86	SJ23580	4.708	< .7	8.003	.2	< 1	160	.1	< .1
05/12/86	SJ23709	2.176	< .6	8.139	< .2	< 1	6.9	.2	.1
05/19/86	SJ23838	< 1.255 B	< .7	7.877 B	< .2 B	< 1	< .6 B	.1 B	.05 B
06/03/86	SJ24104	1.903	< .5	7.025	< .1	< 1	< .1	.1	.1
06/10/86	SJ24278	1.845	< .6	8.260	14	< 1	< .2	< .2	< .2
06/17/86	SJ24505	3.114	< .7	8.262	380	< 1	< .2	.2	.1
06/23/86	SJ24679	< 1.000	< .5	8.110	19	< 1	< .1	< .1	< .1
06/30/86	SJ24829	2.000	< .6	7.337	63	< 1	< .2	.1	< .1
07/22/86	SJ25338	< 1.301	< .6	7.909	< .2 D	< 1	< .2	.2	.2
07/29/86	SJ25577	3.663	< .6	8.362	140	< 1	< .2	1.0	.7
08/04/86	SJ25797	2.398	< .6	6.873	63	< 1	< .2	< .1	< .1
08/12/86	SJ25996	2.813	< .6	7.792	1500	< 1	< .2	.6	.3
08/19/86	SJ26173	4.398	< .7	8.041	38000 D	< 1	< .2	< .2	< .2
08/27/86	SJ26351	3.172 B	< .6 B	7.845	5400 B	< 1 B	< .2	.1	< .1
09/02/86	SJ26589	3.580	< .6	6.740	3700	< 1	< .2	.1	< .1
09/08/86	SJ26684	5.146	< .6	8.799	660	< 1	< .2	< .1	< .1
09/16/86	SJ26960	2.699	< .5	8.863	3.1	< 1	< .1	.2	.1
09/22/86	SJ27109	2.505	< .6	8.580	320	< 1	< .1	< .1	< .1
09/29/86	SJ27470	2.929	< .7	8.431	2	< 1	< .2	< .1	< .1
10/06/86	SJ27451	4.114	< .6	7.362	15000	< 1	< .2	.2	< .1
10/14/86	SJ27753	1.699	< .7	7.568	160	< 1	< .2	.6	.4
10/20/86	SJ27948	3.491	< .7	9.079	68000 D	< 1	< .2	.4	< .1
10/27/86	SJ28167	3.000 D	< .7	6.863	7200	< 1	< .2	.1	< .1
11/03/86	SJ28414	3.556	< .7	8.944	38000	< 1	< .2	< .09	< .09
11/10/86	SJ28483	4.431	< .7	9.176	43000	< 1	< .2	< .1	< .1
11/24/86	SJ29031	3.663	< .7	9.176	410	< 1	6.2	.5	.1
12/01/86	SJ29379	4.230	< .7	9.041	42000	< 1	< .2	< .09	< .09
12/08/86	SJ29390	4.242 B,D	< .7 B	9.113 B	85000 B	< 1 B	< .2 B	.78 B	.7 B
12/23/86	SJ29591	4.491 D	< .8	9.176	1400	< 1	43	.1	.1
12/30/86	SJ30404	4.505 D	< .8	8.708	19	< 1	480 D	< .1	< .1
01/06/87	SJ30413	2.301	< .8	8.959	3.1	< 1	440	< .2	< .2
01/12/87	SJ30492	4.204 D	< .8	8.690	46	< 1	930	< .2	< .2
01/20/87	SJ30659	2.708 D	< 1	8.699	5.6	< 1	29	< .2	< .2
01/27/87	SJ31372	3.813 D	< .9	8.613	< .2	< 1	960000	< .2	< .2

TABLE C2 CONT'D. SITE: III-B-2 STATIC PILE COMPOST - SCREENED

SAMPLE TEST RESULTS

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
01/23/86	SJ20647	< .1	.1	< .1	< .1	< .04
01/27/86	SJ20818	< .2	.2	< .2	< .2	< .05
03/05/86	SJ21605	< .1	.2	< .1	< .1	< .04
03/10/86	SJ21788	< .2	.5	< .2	< .2	< .04
03/17/86	SJ21935	< .1	.1	< .1	< .1	< .07
03/24/86	SJ22184	< .1	.2	< .1	< .1	< .06
03/31/86	SJ22831	< .1	.3	< .1	< .1	< .06
04/07/86	SJ22609	< .1	.1	< .1	< .1	< .07
04/15/86	SJ22932	< .1	< .1	< .1	< .1	< .06
04/22/86	SJ23132	< .1	.4	< .1	< .1	< .06
04/29/86	SJ23311	< .2	.2	< .2	< .2	< .07
05/05/86	SJ23580	< .1	.1	< .1	< .1	< .06
05/12/86	SJ23709	< .1	.1	< .1	< .1	< .05
05/19/86	SJ23838	< .05 B	.05 B	< .05 B	< .05 B	< .06
06/03/86	SJ24104	< .1	< .1	< .1	< .1	< .04
06/10/86	SJ24278	< .2	< .2	< .2	< .2	< .05
06/17/86	SJ24505	< .1	.1	< .1	< .1	< .06
06/23/86	SJ24679	< .1	< .1	< .1	< .1	< .04
06/30/86	SJ24829	< .1	.1	< .1	< .1	< .05
07/22/86	SJ25338	< .2	< .2	< .2	< .2	< .06
07/29/86	SJ25577	< .1	.3	< .1	< .1	< .05
08/04/86	SJ25797	< .1	< .1	< .1	< .1	< .05
08/12/86	SJ25996	< .2	.3	< .2	< .2	< .06
08/19/86	SJ26173	< .2	< .2	< .2	< .2	< .06
08/27/86	SJ26351	< .1	.1	< .1	< .1	< .05
09/02/86	SJ26589	< .1	.1	< .1	< .1	< .06
09/08/86	SJ26684	< .1	< .1	< .1	< .1	< .06
09/16/86	SJ26960	< .1	.1	< .1	< .1	< .05
09/22/86	SJ27109	< .1	< .1	< .1	< .1	< .05
09/29/86	SJ27470	< .1	< .1	< .1	< .1	< .07
10/06/86	SJ27451	< .1	.2	< .1	< .1	< .06
10/14/86	SJ27753	< .1	.1	< .1	.1	< .06
10/20/86	SJ27948	< .1	< .1	< .1	.4	< .06
10/27/86	SJ28167	< .1	.1	< .1	< .1	< .06
11/03/86	SJ28414	< .09	< .09	< .09	< .09	< .06
11/10/86	SJ28483	< .1	< .1	< .1	< .1	< .07
11/24/86	SJ29031	< .1	.1	< .1	.3	< .06
12/01/86	SJ29379	< .09	< .09	< .09	< .09	< .07
12/08/86	SJ29390	< .05 B	.08 B	< .05 B	< .05 B	< .06 B
12/23/86	SJ29591	< .1	< .1	< .1	< .1	< .07
12/30/86	SJ30404	< .1	< .1	< .1	< .1	< .09
01/06/87	SJ30413	< .2	< .2	< .2	< .2	< .08
01/12/87	SJ30492	< .2	< .2	< .2	< .2	< .08 D
01/20/87	SJ30659	< .2	< .2	< .2	< .2	< .09
01/27/87	SJ31372	< .2	< .2	< .2	< .2	< .08

FOOTNOTE(S) :

B - AVERAGE OF DUPS
D - RETESTED

TABLE C4 SITE: IX-A-2 WINDROW COMPOST - RECYCLE

• SAMPLE TEST RESULTS • • • • • • • • • • • • • • • • • •

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
01/16/86	SJ20443	54.3	4.899	4.899	3.627	8.784	8.578	3.726	2.469
07/31/86	SJ25571	63.0	1.562	< .5 M	4.377	6.819	6.055	< 1.000	< 1.000
08/07/86	SJ25792	61.8	2.842	2.842	5.177	8.890	7.493	1.000	1.699
08/14/86	SJ25990	57.2	< .5 M	< .5 M	2.604	7.727	4.845	1.954	< 1.000
08/21/86	SJ26167	63.6	< .5 M	< .5 M	3.176	6.633 D	6.519 D	3.114	< 1.000
08/28/86	SJ26345	53.4	.301	< .6 M	5.447	8.398 D	6.820 D	< 1.000	< 1.000
09/11/86	SJ26678	68.5	.6 D,M	.6 D,M	2.531	7.176	4.982	< 1.000	< 1.000
09/18/86	SJ26954	60.7	3.580	3.580	3.580	8.431 D	3.813 D	< 1.000	3.987
09/25/86	SJ27103	53.4	.301	< .6 M	.301	6.982	5.079	< 1.000	< 1.000
10/02/86	SJ27464	56.7	6.310 B,D	3.310 B,D	3.618 B	8.244 B	7.388 B	< 1.000	< 1.000
10/09/86	SJ27445	53.5	4.230	1.903	2.903	9.079 D	8.771 D	< 1.000	< 1.000
10/16/86	SJ27747	53.2	4.591	1.908	4.230	8.653	8.279	5.322	< 1.000
10/23/86	SJ27942	55.1	.7 M	< .5 M	1.146	7.531 D	5.146 D	< 1.000	< 1.000
10/30/86	SJ28161	52.6	< .6 M	< .6 M	4.643	8.447	4.462	< 1.000	< 1.000
11/06/86	SJ28408	55.3	3.146	2.851	3.623	7.633	5.079	< 1.000	2.690
11/13/86	SJ28477	60.9	2.580	2.176	3.851	8.380 D	4.079 D	1.301	< 1.000
11/26/86	SJ29025	54.9	3.431	2.892	3.892	8.342	7.959	< 1.000	< 1.000
12/04/86	SJ29373	56.6	.881	< .5 M	2.613	8.176	5.041	< 1.000	< 1.000

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	VERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
01/16/86	SJ20443	< 1.265	< .7	5.937	< .2	< 1	< .2	1.9	1.1
07/31/86	SJ25571	< 1.301	< .6	7.152 D	< .2	< 1	< .2	1.0	< .1
08/07/86	SJ25792	< 1.301	< .6	6.173	< .2	< 1	< .1	.7	.2
08/14/86	SJ25990	< 1.301	< .7	7.419	< .2	< 1	< .2	2	< .1
08/21/86	SJ26167	< 1.301	< .6	6.041 D	< .2	< 1	< .2	2.2	.2
08/28/86	SJ26345	< 1.301	< .8	7.415	< .2	< 1	< .2	1.2	.3
09/11/86	SJ26678	< 1.000	< .6	5.544	< .1	< 1	< .1	.2	< .08
09/18/86	SJ26954	< 1.301	< .7	6.929 D	< .2	< 1	< .2	1	< .1
09/25/86	SJ27103	< 1.301	< .7	7.820 D	< .2	< 1	< .2	2.1	.1
10/02/86	SJ27464	< 1.301 B	< .7 B	8.097 B	< .2 B	< 1 B	< .2 B	.8 B	< .05 B
10/09/86	SJ27445	< 1.301	< .8	8.756	< .2	< 1	< .2	.7	< .1
10/16/86	SJ27747	< 1.301	< .8	7.792	< .2	< 1	< .2	.9	< .1
10/23/86	SJ27942	< 1.301	< .7	6.342	< .2	< 1	< .2	.6	< .1
10/30/86	SJ28161	< 1.301	< .8	4.462	< .2	< 1	< .2	< .1	< .1
11/06/86	SJ28408	< 1.301	.7	6.699	< .2	< 1	< .2	.1	< .1
11/13/86	SJ28477	< 1.301	< .7	8.079	< .2	< 1	< .2	.2	< .1
11/26/86	SJ29025	< 1.301	< .7	7.763	< .2	< 1	< .2 D	.7	< .1
12/04/86	SJ29373	< 1.301	< .7	8.079	< .2	< 1	< .2	.1	< .07

TABLE C4 CONT'D SITE: IX-A-2 WINDROW COMPOST - RECYCLE

SAMPLE TEST RESULTS

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
01/16/86	SJ20443	< .1	.8	< .1	< .1	< .05
07/31/86	SJ25571	< .1	1	< .1	< .1	< .06
08/07/86	SJ25792	< .1	.5	< .1	< .1	< .06
08/14/86	SJ25990	< .1	2	< .1	< .1	< .07
08/21/86	SJ26167	< .1	2	< .1	< .1	< .08
08/28/86	SJ26345	< .1	.9	< .1	< .1	< .08
09/11/86	SJ26678	< .08	.2	< .08	< .08	< .06
09/18/86	SJ26954	< .1	1	< .1	< .1	< .07
09/25/86	SJ27103	< .1	2	< .1	< .1	< .07
10/02/86	SJ27464	< .05 B	.8 B	< .05 B	< .05 B	< .07
10/09/86	SJ27445	< .1	.7	< .1	< .1	< .08
10/16/86	SJ27747	< .1	.9	< .1	< .1	< .07
10/23/86	SJ27942	< .1	.6	< .1	< .1	< .07
10/30/86	SJ28161	< .1	< .1	< .1	< .1	< .07
11/06/86	SJ28408	< .1	.1	< .1	< .1	< .07
11/13/86	SJ28477	< .1	.2	< .1	< .1	< .06
11/26/86	SJ29025	< .1	.7	< .1	< .1	< .07
12/04/86	SJ29373	< .07	.1	< .07	< .07	< .07

FOOTNOTE(S) :

B - AVERAGE OF DUPS
D - RETESTED
M - UNIT = MPN/G

TABLE C3 SITE: IX-A-1 WINDROW COMPOST - SAWDUST

* S A M P L E T E S T R E S U L T S * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
01/16/86	SJ20442	40.2	4.364	4.029	3.758	9.464	6.215	3.765	3.623
01/23/86	SJ20645	43.0	7.335	7.335	2.728	9.581	6.548	4.876	3.531
01/30/86	SJ20812	40.9	6.750	4.343	4.750	9.386	7.583	2.835	4.752
02/06/86	SJ21046	43.0	7.335	7.335	5.000	9.935	7.392	3.082	3.484
02/14/86	SJ21175	60.5	5.920 B	4.216 B	3.520 B	9.106 B	8.572 B	3.885	3.148
02/20/86	SJ21291	32.7	6.119	4.454	4.076	9.352	6.507	4.373	2.741
02/27/86	SJ21416	33.4	5.110	4.838	2.110	8.661	8.184	4.423	2.078
03/06/86	SJ21599	36.8	5.403	5.068	3.309	9.526	9.106	5.051	3.968
03/13/86	SJ21782	40.0	5.778	3.760	3.760	9.187	8.084	< 1.176	3.088
03/20/86	SJ21929	35.1	5.088	5.088	1.088	9.268	9.040	5.124	3.336
03/27/86	SJ22178	36.9	4.609	4.308	1.737	9.372	9.269	> 6.211	3.173
04/03/86	SJ22825	39.7	4.763 B	4.763 B	2.681 B	8.716	8.511 B	4.500 B	3.601 B
04/10/86	SJ22603	42.2	3.250	1.551	2.008	9.091	6.993	2.299	3.028
04/17/86	SJ22926	45.2	.978	.978	.707	7.253	6.141	< 1.190	< 1.190
04/24/86	SJ23126	39.5	.005	< .8 M	< .8 D,M	7.736	8.196	< 1.249	< 1.249
04/30/86	SJ23306	48.2	1.679	.271	1.285	8.313 D	5.037 D	< 1.162	3.156
05/08/86	SJ23574	47.1	.689	< .6 M	.918	8.656	6.724	< 1.172	< 1.172
05/15/86	SJ23703	48.7	2.946	2.946	2.674	8.614	6.892	2.459	2.011
05/22/86	SJ23832	50.5	1.930	.658	.8 M	7.203	6.677	< 1.142	2.376
05/29/86	SJ23945	57.5	4.621	3.874	3.416	8.965	6.709	4.140	3.737
06/05/86	SJ24098	52.5	2.248	2.248	.642	8.457	8.028	4.813	4.875
06/12/86	SJ24272	72.1	.504	.6 M	2.604	7.874 D	6.253 D	< 1.000	< 1.000
06/19/86	SJ24499	57.5	.602	< .5 M	2.602	7.358	7.076	< 1.000	< 1.000
06/26/86	SJ24673	54.9	.011	.011	3.737 B	8.311 D	5.060 D	< 1.000 B	< 1.000 B
07/03/86	SJ24823	61.2	< .5 M	< .5 M	< .5 M	7.537	5.871	< 1.000	< 1.000
07/10/86	SJ24982	62.2	.6 M	< .5 M	5.278	7.859 D	4.712 D	< 1.000	< 1.000
07/17/86	SJ25180	67.7	< .4 M	< .4 M	4.832	8.918 D	9.277 D	< 1.000	< 1.000
07/24/86	SJ25332	70.7	< .4 M	< .4 M	4.119	8.377	4.682	< 1.000	< 1.000
08/28/86	SJ26344	52.7	< .6 M	< .6 M	3.146	7.230 D	5.230 D	< 1.000	< 1.000
09/04/86	SJ26583	61.3	< .5 M	< .5 M	.000	5.940	5.886 D	< 1.000	< 1.000
12/11/86	SJ29384	56.2	5.886	4.886	3.431	8.176	5.342	< 1.000	< 1.000
12/18/86	SJ29585	57.0	1.875	1.204	2.602	8.079 D	6.079 D	< 1.000	< 1.000
12/31/86	SJ30398	49.7	4.279	4.279	3.940	8.991	8.255	< 1.000	3.681
01/08/87	SJ30407	40.6	5.362	2.568	2.756	8.146	5.176	< 1.301	< 1.301
01/15/87	SJ30486	46.2	.301	< .6 M	2.301	8.342	4.681	2.301	2.924
01/22/87	SJ30653	45.4 D	3.708 B	3.343 B	2.410 B	8.518	5.820	1.477 B	3.230 B

TABLE C3 CONT'D. SITE: IX-A-1 WINDROW COMPOST - SAWDUST

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	YERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
01/16/86	SJ20442	2.350	< 1	9.543	< .2	< 1	< .2	5.3	5.1
01/23/86	SJ20645	< 1.367	< .9	8.508	.7	< 1	< .2	3.2	.5
01/30/86	SJ20812	1.689	< 1	9.051	< .2	< 1	< .2	1.3	< .2
02/06/86	SJ21046	2.571	< .9	9.603	< .2	< 1	< .2	2	1
02/13/86	SJ21175	2.260	< .7	7.578 B	3.8 B	< 1	.7 B	1.9 B	1.0 B
02/20/86	SJ21291	2.331	< 1	7.829	< .3	< 1	< .3	4.6	1.8
02/27/86	SJ21416	< 1.175	< 1	7.328	< .3	< 1	< .3	6.2	2.7
03/06/86	SJ21599	< 1.434	< 1	8.146	< .3	< 1	< .3	1.2	1.0
03/13/86	SJ21782	< 1.398	< 1	8.528	< .2	< 1	< .2	2.7	.9
03/20/86	SJ21929	< 1.447	< 1	7.685	< .3	< 1	< .3	2.6	< .2
03/27/86	SJ22178	2.279	< 1	7.591	< .3	< 1	< .3	4.3	3.3
04/03/86	SJ22825	2.362	< 1	7.893 B	34 B	< 1	< .2 B	2.9	.7
04/10/86	SJ22603	< 1.380	< 1	7.766	< .2	< 1	< .2	.8	.3
04/17/86	SJ22926	< 1.042	< .9	< 2.345	< .2	< 1	< .2	1	< .2
04/24/86	SJ23126	3.000	< 1	6.278	< .2	< 1	< .2	6	4
04/30/86	SJ23306	< 1.021	< .8	6.438	< .2	< 1	< .2	2.5	.5
05/08/86	SJ23574	2.322	< .9	7.172	< .2	< 1	< .1	2.2	.2
05/15/86	SJ23703	1.792	< .8	7.718	< .2	< 1	< .2	2.6	1.6
05/22/86	SJ23832	2.898	< .8	5.120	< .2	< 1	< .2	1.2	.3
05/29/86	SJ23945	< 1.230	< .7	6.063	< .2	< 1	< .2	2.3	.3
06/05/86	SJ24098	1.279	< .8	7.241	< .2	< 1	< .2	.8	.2
06/12/86	SJ24272	< 1.000	< .6	6.467	< .1	< 1	< .1	.3	< .1
06/19/86	SJ24499	< 1.301	< .7	6.992	< .2	< 1	< .2	.5	.2
06/26/86	SJ24673	1.301 B	< .7 B	6.487 B	< .2 B	< 1 B	< .2 B	3 B	< .05 B
07/03/86	SJ24823	< 1.301	< .6	7.150	< .2	< 1	< .2	2	< .1
07/10/86	SJ24982	< 1.301	< .6	6.489	< .2	< 1	< .2	1.4	.5
07/17/86	SJ25180	< 1.000	< .6	9.277 D	< .2	< 1	< .2	.5	< .1
07/24/86	SJ25332	< 1.000	< .6	7.656	< .1	< 1	< .1	.8	< .1
08/28/86	SJ26344	< 1.301	< .8	7.778 D	< .2 D	< 1	< .2	1.1	.1
09/04/86	SJ26583	< 1.301	< .6	4.322 D	< .2	< 1	< .2	.7	< .1
12/11/86	SJ29384	< 1.301 D	< .7	6.176	< .2	< 1	< .2	1.0	.3
12/18/86	SJ29585	< 1.301 D	< .7	6.724	< .2	< 1	< .2	.1	< .1
12/31/86	SJ30398	< 1.301 D	< .8	8.431	< .2	< 1	< .2	< .1	< .1
01/08/87	SJ30407	< 1.301 D	< 1	7.398	< .2	< 1	< .2	< .2	< .2
01/15/87	SJ30486	< 1.301 D	< .9	6.556	< .2	< 1	< .2	< .1	< .1
01/22/87	SJ30653	< 1.301 B,D	< .9 B	7.591	< .2	< 1 B	< .2	.2	.2

TABLE C3 CONT'D. SITE: IX-A-1 WINDROW COMPOST - SAWDUST

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * *

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
01/16/86	SJ20442	< .2	.2	< .2	< .2	< .06
01/23/86	SJ20645	< .2	2.7	< .2	< .2	< .06
01/30/86	SJ20812	< .2	1.3	< .2	< .2	< .06
02/06/86	SJ21046	< .1	.9	< .1	< .1	< .06
02/13/86	SJ21175	< .1 B	1.0 B	< .1 B	< .1 B	< .04
02/20/86	SJ21291	< .2	2.8	< .2	< .2	< .08
02/27/86	SJ21416	< .2	3.4	< .2	< .2	< .08
03/06/86	SJ21599	< .2	.2	< .2	< .2	< .07
03/13/86	SJ21782	< .2	1.4	< .2	.4	< .06
03/20/86	SJ21929	< .2	2.6	< .2	< .2	< .1
03/27/86	SJ22178	< .2	1.0	< .2	< .2	< .1
04/03/86	SJ22825	< .2	2	< .2	.2	< .09
04/10/86	SJ22603	< .1	.5	< .1	< .1	< .09
04/17/86	SJ22926	< .2	1	< .2	< .2	< .08
04/24/86	SJ23126	< .2	2	< .2	< .2	< .1
04/30/86	SJ23306	< .2	2	< .2	< .2	< .08
05/08/86	SJ23574	< .2	2	< .2	< .2	< .06
05/15/86	SJ23703	< .1	1	< .1	< .1	< .08
05/22/86	SJ23832	< .1	.9	< .1	< .1	< .07
05/29/86	SJ23945	< .1	2	< .1	< .1	< .06
06/05/86	SJ24098	< .1	.6	< .1	< .1	< .06
06/12/86	SJ24272	< .1	.3	< .1	< .1	< .05
06/19/86	SJ24499	< .2	.3	< .2	< .2	< .06
06/26/86	SJ24673	< .05 B	3 B	< .05 B	< .05 B	< .07
07/03/86	SJ24823	< .1	2	< .1	< .1	< .05
07/10/86	SJ24982	< .1	.9	< .1	< .1	< .07
07/17/86	SJ25180	< .1	.5	< .1	< .1	< .07
07/24/86	SJ25332	< .1	.8	< .1	< .1	< .06
08/28/86	SJ26344	< .1	1	< .1	< .1	< .07
09/04/86	SJ26583	< .1	.7	< .1	< .1	> .06 A
12/11/86	SJ29384	< .1	.7	< .1	< .1	< .07
12/18/86	SJ29585	< .1	.1	< .1	< .1	< .06
12/31/86	SJ30398	< .1	< .1	< .1	< .1	< .08
01/08/87	SJ30407	< .2	< .2	< .2	< .2	< .09
01/15/87	SJ30486	< .1	< .1	< .1	< .1	< .08
01/22/87	SJ30653	< .2	< .2	< .2	< .2	< .08 B

FOOTNOTE(S) :

A - POSSIBLE CONTAMINATION BY SPIKE
B - AVERAGE OF DUPS
D - RETESTED
M - UNIT = MPN/G

TABLE C5 SITE: IX-A-3 BAGGED PRODUCT

SAMPLE TEST RESULTS

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
01/16/86	SJ20444	57.6	5.220	4.873	6.902	8.478	8.174	3.066	2.085
01/23/86	SJ20644	54.2	5.899	5.628	5.797	8.978	8.909	4.425	3.334
01/30/86	SJ20813	64.4	6.854	5.825	5.825	9.133	6.911	4.355	2.899
02/06/86	SJ21047	71.0	6.117	4.024	7.190	9.180	7.380	2.667	1.751
02/13/86	SJ21176	74.3	2.491	2.491	5.491	9.210	6.595	< 1.430	1.606
02/20/86	SJ21292	68.5	6.299 B	5.329 B	6.516 B	9.097 B	8.108 B	3.981 B	3.579 B
02/27/86	SJ21417	64.7	2.511	2.064	3.551	7.892	7.300	1.189	2.490
03/06/86	SJ21600	72.0	4.776	4.097	5.319	9.252	7.118	3.453	2.648
03/13/86	SJ21783	68.8	4.525	3.525	4.486	8.234	8.176	< .942	2.067
03/20/86	SJ21930	74.4	< .4 M	< .4 M	3.097	8.685	4.888	< 1.128	< 1.128
03/27/86	SJ22179	70.2	5.534	5.122	5.122	8.844	7.120	4.202	3.274
04/03/86	SJ22826	70.8	3.783	3.326	4.512	7.836	6.747	< .995	< .995
04/10/86	SJ22604	76.3 B	4.595 B	4.251 B	5.576 B	9.281 B	7.518 B	2.373	2.231
04/17/86	SJ22927	74.6	4.761	4.489	5.096	8.766	7.229	3.199	2.960
04/24/86	SJ23127	76.6	4.749	3.749	6.157	8.607	7.259	< .961	2.496
04/30/86	SJ23307	72.4	6.109	5.109	5.774	8.950	6.529	4.605	4.545
05/08/86	SJ23575	54.1	6.629 D	6.235 D	5.900	9.083	8.600	4.567	3.725
05/15/86	SJ23704	70.3	.8 M	< .4 M	4.533	8.516 D	5.893 D	5.384	.998
05/22/86	SJ23833	70.4	6.815	5.786	6.329	9.261	8.016	3.329	2.979
05/29/86	SJ23946	71.0	4.782	3.782	5.510 D	8.994 D	5.699 D	3.485	2.927
06/05/86	SJ24099	77.6	3.985 D	3.985 D	5.432	8.773	7.568	2.929	2.322
06/12/86	SJ24273	76.3	1.294	1.294	4.498	9.240	8.157	3.322	2.748
06/19/86	SJ24500	76.7	4.477 D	4.084 D	5.437 D	10.102 D	5.918 D	4.663	3.255
06/26/86	SJ24674	55.7	2.888	2.616	5.888	8.922	5.779	3.279	3.079
07/03/86	SJ24824	75.9	2.477 B	1.418 B	4.616 B	8.708	4.973	< .954 B	< .954 B
07/10/86	SJ24984	70.1	.6 M	.6 M	4.477	8.844	5.310	< 1.000	< 1.000
07/17/86	SJ25181	78.9	4.483	3.736	4.565	8.558 D	7.207 D	4.146	3.146
07/24/86	SJ25333	77.1	2.475	1.475	4.746	9.309 D	7.432 D	2.886	2.845
07/31/86	SJ25572	77.8	2.471	.063	4.471	8.516 D	5.722 D	< 1.000	< .954
08/07/86	SJ25793	60.8	4.185	1.807	4.578	7.834	6.778	< 1.000	< 1.000
08/14/86	SJ25991	73.2	< .4 M	< .4 M	3.492	8.171 D	5.542 D	2.681	2.204
08/21/86	SJ26168	75.6	3.477	2.477	5.477	8.771 D	7.415 D	< .954	< .954
08/28/86	SJ26346	77.3	2.079	1.748	3.477	8.531	5.653	3.959	2.820
09/04/86	SJ26584	84.5	.000	.5 M	3.708 D	8.653	5.204	1.602	< .903
09/11/86	SJ26679	76.7	3.748	3.748	3.477	7.799	7.544	< 1.000	< 1.000
09/18/86	SJ26955	75.5	3.477	3.477	4.756	8.491	7.613	< .954	< .954
09/25/86	SJ27104	72.2	4.806	4.806	4.778 D	8.663	7.839	< 1.000	< 1.000
10/02/86	SJ27465	59.1	7.613 D	6.204 D	4.204	9.279	8.462	6.000	6.114
10/09/86	SJ27446	61.4	4.380	2.568	6.255	8.839	6.602	3.380	< 1.000
10/16/86	SJ27748	64.7	5.851 B	5.459 B	5.688 B	8.746 B,D	6.898 B,D	4.580 B	3.732 B

TABLE C5 CONT'D. SITE: IX-A-3 BAGGED PRODUCT

* SAMPLE TEST RESULTS *

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
10/23/86	SJ27943	60.0	3.204	3.204	5.580	8.681	8.041	3.591	3.279
10/30/86	SJ28162	56.4	4.613	4.613	5.114	8.477	5.748	2.000	< 1.000
11/06/86	SJ28409	61.2	2.176	2.176	3.176	8.322	6.079	2.000	3.146
11/13/86	SJ28478	61.4	4.380	4.176	4.845	8.934	7.934	1.903	3.544
11/26/86	SJ29026	57.5	2.415	2.415	3.602	8.176	7.176	< 1.000	< 1.000
12/04/86	SJ29374	57.5	3.447	2.602	3.875	8.924 D	7.839 D	4.799	< 1.000
12/11/86	SJ29385	54.6	4.898	3.898	5.230	9.230	4.875	4.556	2.881
12/18/86	SJ29586	52.3	4.643	4.255	4.643	8.771	4.964	< 1.000	< 1.000
12/31/86	SJ30399	51.4	5.653	5.255	4.881	8.556	7.724	< 1.000	< 1.000
01/08/87	SJ30408	53.0	.633	.633	4.255	7.857	4.826	< 1.000	< 1.000
01/15/87	SJ30487	55.3	2.230	2.230	4.623	8.380	4.602	1.602	1.845
01/22/87	SJ30654	58.6	4.204	4.204	5.204	8.845	4.908	1.301	< 1.000

TABLE C5 CONT'D SITE: IX-A-3 BAGGED PRODUCT

SAMPLE TEST RESULTS

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	VERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
01/16/86	SJ20444	2.416	< .7	7.421	< .2	< 1	< .2	.7	.1
01/23/86	SJ20644	1.266	< .7	8.102	< .2	< 1	< .2	.7	.2
01/30/86	SJ20813	3.403	< .6	9.126	6.7	< 1	< .2	.7	.2
02/06/86	SJ21047	3.644	< .6	8.343	< .1	< 1	< .1	< .1	< .1
02/13/86	SJ21176	2.509	< .5	6.461	< .1	< 1	< .1	< .1	< .1
02/20/86	SJ21292	3.275 B	< .6	8.855 B	180 B	< 1 B	1	.5 B	.3
02/27/86	SJ21417	1.791	< .6	8.206	< .2	< 1	< .2	1.0	.4
03/06/86	SJ21600	2.722	< .6	8.109	< .1	< 1	< .1	.4	.1
03/13/86	SJ21783	1.641	< .6	9.351	< .2	< 1	< .2	.1	< .1
03/20/86	SJ21930	1.431	< .5	4.135	< .1	< 1	< .1	1.1	1.1
03/27/86	SJ22179	4.176	< .6	8.158	< .1	< 1	< .1	.6	.1
04/03/86	SJ22826	2.322	< .6	7.450	< .1	< 1	< .1	.1	.1
04/10/86	SJ22604	2.447	< .5	6.635 B	< .1 B	< 1 B	< .1	< .1 B	< .1 B
04/17/86	SJ22927	3.544	< .5	7.544	< .1	< 1	< .1	.3	.1
04/24/86	SJ23127	2.398	< .5	6.872	< .1	< 1	< .1	< .1	< .1
04/30/86	SJ23307	2.505	< .6	7.264	< .1	< 1	< .1	.2	.2
05/08/86	SJ23575	2.176	< .7	8.214	2	< 1	< .2	3.4	.4
05/15/86	SJ23704	2.491	< .6	7.744	< .2	< 1	< .2	< .1	< .1
05/22/86	SJ23833	3.146	< .6	8.114	1.6	< 1	< .1	< .1	< .1
05/29/86	SJ23946	2.653	< .6	8.432	< .1	< 1	< .1	.3	.1
06/05/86	SJ24099	2.857	< .5	5.525	< .1	< 1	< .1	< .1	< .1
06/12/86	SJ24273	1.000	1.6	4.720 D	< .1	< 1	< .1	< .1	< .1
06/19/86	SJ24500	2.833	< .5	6.091	< .1	< 1	< .1	.1	< .1
06/26/86	SJ24674	3.041	< .7	6.053	< .2	< 1	< .2	.5	< .1
07/03/86	SJ24824	1.845 B	< .5 B	4.634 D	< .1 B	< 1 B	< .1 B	< .05 B	< .05 B
07/10/86	SJ24984	< 1.000	< .6	6.456 D	< .1	< 1	< .1	< .1	< .1
07/17/86	SJ25181	3.505	< .5	5.789	< .1	< 1	< .1	< .1	< .1
07/24/86	SJ25333	< 1.000	1.6	5.037 D	< .1	< 1	< .1	.09	< .09
07/31/86	SJ25572	3.851	< .5	6.183	< .1	< 1	< .1	.06	< .06
08/07/86	SJ25793	< 1.301	< .7	7.888	< .2	< 1	< .2	< .1	< .1
08/14/86	SJ25991	< 1.000	< .6	6.794	< .1	< 1	< .1	< .1	< .1
08/21/86	SJ26168	1.602	< .5	5.477	< .1	< 1	< .1	< .1	< .1
08/28/86	SJ26346	< 1.000	< .5	7.785	< .1	< 1	< .1	< .09	< .09
09/04/86	SJ26584	< 1.000	< .5	3.799 D	< .1	< 1	< .1	< .09	< .09
09/11/86	SJ26679	< 1.000	< .5	7.857 D	< .1	< 1	< .1	< .09	< .09
09/18/86	SJ26955	2.204	< .5	5.763 D	< .1	< 1	< .1	< .1	< .1
09/25/86	SJ27104	3.322	< .6	7.699 D	< .1	< 1	< .1	< .1	< .1
10/02/86	SJ27465	< 1.301	< .7	8.301	< .2	< 1	< .2	.1	< .1
10/09/86	SJ27446	2.000	< .6	9.041	< .2	< 1	< .2	.8	< .1
10/16/86	SJ27748	2.151 B	< .6 B	8.155 B	1400 B	< 1 B	< .2 B	.5 B	< .05 B

TABLE C5 CONT'D SITE: IX-A-3 BAGGED PRODUCT

SAMPLE TEST RESULTS

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	VERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
10/23/36	SJ27943	< 1.301	< .7	7.301	2	< 1	< .2	.5	< .1
10/30/86	SJ28162	< 1.301	< .7	7.839	2	< 1	< .2	.3	< .1
11/06/86	SJ28409	< 1.301	< .6	8.230	< .2	< 1	< .2	.1	< .1
11/13/86	SJ28478	< 1.301	2.0	8.477	.7	< 1	< .2	.1	< .1
11/26/86	SJ29026	< 1.301	< .7	8.342	< .2	< 1	< .2	.5	< .1
12/04/86	SJ29374	< 1.301	.7	8.279	< .2	< 1	< .2	< .1	< .1
12/11/86	SJ29385	< 1.301 D	< .7	8.041	17	< 1	< .2	1	< .1
12/18/86	SJ29586	< 1.301 D	< .8	8.519	< .2	< 1	< .2	.2	< .2
12/31/86	SJ30399	1.778 D	< .8	7.322	< .2	< 1	< .2	.3	< .1
01/08/87	SJ30408	< 1.301 D	< .6	7.041	< .2	< 1	< .2	.1	< .1
01/15/87	SJ30487	< 1.301 D	< .7	7.255	< .2	< 1	< .2	< .1	< .1
01/22/87	SJ30654	< 1.301 D	< .7	8.342	< .2	< 1	< .2	< .1	< .1

TABLE C5 CONT'D. SITE: IX-A-3 BAGGED PRODUCT

• SAMPLE TEST RESULTS • • • • • • • • • • • • • • • • • • •

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
01/16/86	SJ20444	< .1	.6	< .1	< .1	< .04
01/23/86	SJ20644	< .2	.5	< .2	< .2	< .05
01/30/86	SJ20813	< .1	.5	< .1	< .1	< .04
02/06/86	SJ21047	< .1	< .1	< .1	< .1	< .04
02/13/86	SJ21176	< .1	< .1	< .1	< .1	< .03
02/20/86	SJ21292	< .1	.1	< .1	< .1	< .04
02/27/86	SJ21417	< .1	1.0	< .1	< .1	< .04
03/06/86	SJ21600	< .1	.3	< .1	< .1	< .04
03/13/86	SJ21783	< .1	< .1	< .1	.1	< .04
03/20/86	SJ21930	< .1	< .1	< .1	< .1	< .05
03/27/86	SJ22179	< .1	.4	< .1	.1	< .05
04/03/86	SJ22826	< .1	< .1	< .1	< .1	< .05
04/10/86	SJ22604	< .1 B	< .1 B	< .1 B	< .1 B	< .1
04/17/86	SJ22927	< .1	.1	.1	< .1	< .05
04/24/86	SJ23127	< .1	< .1	< .1	< .1	< .05
04/30/86	SJ23307	< .1	< .1	< .1	< .1	< .05
05/08/86	SJ23575	< .1	3	< .1	< .1	< .06
05/15/86	SJ23704	< .1	< .1	< .1	< .1	< .05
05/22/86	SJ23833	< .1	< .1	< .1	< .1	< .05
05/29/86	SJ23946	< .1	.2	< .1	< .1	< .05
06/05/86	SJ24099	< .1	< .1	< .1	< .1	> .05 A
06/12/86	SJ24273	< .1	< .1	< .1	< .1	< .04
06/19/86	SJ24500	< .1	.1	< .1	< .1	< .05
06/28/86	SJ24674	< .1	.5	< .1	< .1	< .07
07/03/86	SJ24824	< .05 B	< .05 B	< .05 B	< .05 B	< .05 B
07/10/86	SJ24984	< .1	< .1	< .1	< .1	< .06
07/17/86	SJ25181	< .1	< .1	< .1	< .1	< .05
07/24/86	SJ25333	< .09	.09	< .09	< .09	< .05
07/31/86	SJ25572	< .06	.06	< .06	< .06	< .05
08/07/86	SJ25793	< .1	< .1	< .1	< .1	< .06
08/14/86	SJ25991	< .1	< .1	< .1	< .1	< .05
08/21/86	SJ26168	< .1	< .1	< .1	< .1	< .05
08/28/86	SJ26346	< .09	< .09	< .09	< .09	< .05
09/04/86	SJ26584	< .09	< .09	< .09	< .09	< .05
09/11/86	SJ26679	< .09	< .09	< .09	< .09	< .05
09/18/86	SJ26955	< .1	< .1	< .1	< .1	< .05
09/25/86	SJ27104	< .1	< .1	< .1	< .1	< .05
10/02/86	SJ27465	< .1	.1	< .1	< .1	< .07
10/09/86	SJ27446	< .1	.8	< .1	< .1	< .07
10/16/86	SJ27748	< .05 B	.5 B	< .05 B	< .05 B	< .06

TABLE C5 CONT'D. SITE: IX-A-3 BAGGED PRODUCT

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
10/23/86	SJ27943	< .1	.5	< .1	< .1	< .07
10/30/86	SJ28162	< .1	.3	< .1	< .1	< .08
11/06/86	SJ28409	< .1	.1	< .1	< .1	< .06
11/13/86	SJ28478	< .1	.1	< .1	< .1	< .06
11/26/86	SJ29026	< .1	.5	< .1	< .1	< .07
12/04/86	SJ29374	< .1	< .1	< .1	< .1	< .07
12/11/86	SJ29385	< .1	1	< .1	< .1	< .07
12/18/86	SJ29586	< .2	.2	< .2	< .2	< .07
12/31/86	SJ30399	< .1	.3	< .1	< .1	< .08
01/08/87	SJ30408	< .1	.1	< .1	< .1	< .08
01/15/87	SJ30487	< .1	< .1	< .1	< .1	< .06
01/22/87	SJ30654	< .1	< .1	< .1	< .1	< .06

FOOTNOTE(S) :

A - POSSIBLE CONTAMINATION BY SPIKE
B - AVERAGE OF DUPS
D - RETESTED
M - UNIT = MPN/G

TABLE C6 SITE: IX-A-4 BAGGED PRODUCT/RICE HULL MIX

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	TOTAL SOLIDS	TOTAL COLIFORM	FECAL COLIFORM	FECAL STREP	AEROBIC PLATE COUNT	ANAEROBIC PLATE COUNT	TOTAL FUNGI	THERMOPHILIC FUNGI
		%	LOGMPN/G	LOGMPN/G	LOGMPN/G	LOGCFU/G	LOGCFU/G	LOGCFU/G	LOGCFU/G
01/16/86	SJ20445	63.7	5.834	5.079	4.176	9.602	8.964	> .674 J	> .674 J
01/23/86	SJ20643	56.8	7.568	7.568	7.879	9.446	8.216	4.564	4.680
01/30/86	SJ20814	55.5	7.131	7.131	6.617	8.922	7.217	3.739	3.632
02/06/86	SJ21048	48.2	8.192	8.192	7.679	9.657	9.180	2.463	3.673
02/13/86	SJ21177	50.7	7.264	6.928	6.886	9.529	9.132	4.765	> 4.750
02/20/86	SJ21293	44.0	6.325	5.990	5.325	9.380	8.410	4.000	3.436
02/27/86	SJ21418	47.7 B	6.498 B	5.940 B	5.394 B	9.371 B	9.404 B	4.356 B	4.609 B
03/06/86	SJ21601	55.6	7.888	7.431	6.130	9.592	9.432	> 5.133	> 5.037
03/13/86	SJ21784	46.0	8.212	7.699	6.971	9.955	8.448	5.213	4.454
03/20/86	SJ21931	47.5	7.957	7.499	6.685	10.022	8.190	4.678	4.472
03/27/86	SJ22180	46.4	7.302	7.302	5.656	9.429	7.309	3.442	3.268
04/03/86	SJ22827	56.8	8.214	7.568	7.214	9.444	9.106	4.755	5.155
04/10/86	SJ22605	52.9	6.910	6.152	6.868	9.647	9.430	4.388	4.895
04/17/86	SJ22928	54.4 B	6.019 B	5.262 B	6.626 B	8.497 B	8.942 B	5.544 B	5.555 B
04/24/86	SJ23128	51.4	8.611	7.258	6.258	9.302	9.262	5.270	5.375
05/08/86	SJ23576	58.2	7.204	7.204	6.204	9.370	8.559	5.500	6.467
05/15/86	SJ23705	59.0	7.198	6.863	5.591	9.575	9.151	5.698	5.977
05/22/86	SJ23834	58.5	1.595	.7 M	2.108	7.631	6.745	< 1.078	< 1.078
05/29/86	SJ23947	54.6	5.896	5.896	7.231	8.781	8.694	3.335	3.436
06/05/86	SJ24100	57.5	6.874	6.874	6.416	8.952	8.620	4.623	4.230
06/12/86	SJ24274	57.8	6.414	6.113	5.113	7.962	7.661	4.415	3.763
06/19/86	SJ24501	53.6	< .6 D,M	< .6 D,M	1.633 D	8.355 D	6.279 D	< 1.000	5.763 J
06/26/86	SJ24675	74.6	5.761	5.761	6.761 D	9.161	6.790	< 1.000	2.591
07/03/86	SJ24825	60.5	.7 M	< .5 M	3.187	7.349	6.397	< 1.000	4.301
07/10/86	SJ24985	57.3	.604	< .5 M	4.210	6.962	6.594	< 1.000	< 1.000
07/17/86	SJ25182	67.0	4.681 B	4.544 B	4.255 B	9.279	5.929	3.000 B	3.954 B
07/24/86	SJ25334	58.2	5.597	5.204	4.869	9.020	6.912	4.555	4.380
07/31/86	SJ25573	66.3	6.812	6.147	6.220	9.142	7.252	5.431	4.544
08/07/86	SJ25794	59.8	5.585	5.585	4.857	8.780	8.016	> 5.708	2.964
08/14/86	SJ25992	60.1	4.190	4.190	4.855	8.232	6.342	2.580	4.301
08/21/86	SJ26169	66.9	.531 D	.531 D	4.146 D	8.380	6.146	< 1.000	< 1.000
08/28/86	SJ26347	65.3	.544	< .5 M	2.146	6.672	5.756	< 1.000	< 1.000
09/04/86	SJ26585	67.6	< .4 M	< .4 M	.6 M	7.940	6.279	< 1.000	2.763
09/11/86	SJ26680	65.7	6.845 D	6.845 D	6.544 D	9.301	9.079	2.176	2.000
09/18/86	SJ26956	64.6	6.146	6.146	4.826	9.041 D	6.839 D	2.724	2.708
09/25/86	SJ27105	59.8	7.602	6.580	5.580	10.000	7.556	> 5.699	5.623
10/02/86	SJ27466	63.9	4.826	4.826	5.556	8.799	7.756	2.000	2.000
10/09/86	SJ27447	67.5	7.556	7.146	6.833	9.398	7.681	2.785	4.362
10/16/86	SJ27749	67.3	5.531	5.146	5.806	8.833	7.982	2.447	2.987
10/23/86	SJ27944	63.0	6.824 B	6.824 B	6.004 B	9.983 B	7.946 B	4.176 B	3.672 B

TABLE C6 CONT'D. SITE: IX-A-4 BAGGED PRODUCT/RICE HULL MIX

* SAMPLE TEST RESULTS *

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
10/30/86	SJ28163	65.8	4.813 D	4.813 D	5.041 D	9.968	7.146	5.380	4.756
11/06/86	SJ28410	68.0	.491	< .4 M	1.799	9.322	8.944	< 1.000	< 1.000
11/13/86	SJ28479	64.9	5.146 D	4.544 D	3.820	9.944	8.708	5.839	3.944
11/26/86	SJ29027	74.5	.491	.000	3.491	8.146	6.672	< .954	1.602
12/04/86	SJ29375	69.7	< .4 M	< .4 M	3.792	9.633	6.839	5.826	< 1.000
12/11/86	SJ29386	71.0	.6 M	.6 M	3.322	9.322	6.857	5.176	< 1.000
12/18/86	SJ29587	63.4	5.176	3.556	3.556	10.000 D	7.114 D	5.519	5.643
12/31/86	SJ30400	60.1	4.041 D	2.857 D	2.813	10.000	8.863	6.556	5.643
01/08/87	SJ30409	58.8	6.204	5.863	4.591	9.792	6.778	4.934	5.415
01/15/87	SJ30488	53.1	5.447	5.255	5.602	10.176	8.991	3.580	3.869
01/22/87	SJ30655	70.4	6.531	3.740	5.785	9.771	6.940	2.000	2.230

TABLE C6 CONT'D. SITE: IX-A-4 BAGGED PRODUCT/RICE HULL MIX

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	VERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
01/16/86	SJ20445	2.400	< .6	8.954	< .2	< 1	< .2	.6	.1
01/23/86	SJ20643	4.994	< .7	9.020	2.6	< 1	< .2	.9	.5
01/30/86	SJ20814	4.107	< .7	8.835	.5	< 1	< .2	1.2	< .2
02/06/86	SJ21048	4.897	< .8	9.479	8.9	< 1	2	1.2	.6
02/13/86	SJ21177	4.371	< .8	8.793	18	< 1	< .2	1.1	.9
02/20/86	SJ21293	3.330	.9	8.273	< .2	< 1	< .2	1.7	< .2
02/27/86	SJ21418	3.089 B	< .8	8.496 B	.2 B	< 1 B	1.0 B	2.0 B	.4 B
03/06/86	SJ21601	2.773	< .7	8.941	17	< 1	< .2	1.2	.5
03/13/86	SJ21784	5.097	< .9	9.310	.9	< 1	3.3	1.2	1.1
03/20/86	SJ21931	4.987	< .8	9.146	20	< 1	< .2	.9	.3
03/27/86	SJ22180	4.176	< .9	9.078	2.0	< 1	< .2	1.5	.5
04/03/86	SJ22827	4.644	< .7	8.477	16	< 1	< .2	.5	.4
04/10/86	SJ22605	4.634	< .8	8.592	< .2	< 1	< .2	.3	< .1
04/17/86	SJ22928	2.342	< .7	7.911 B	.7 B	< 1 B	< .2 B	.7 B	.1 B
04/24/86	SJ23128	4.146	< .8	8.374	.8	< 1	< .2	.8	.4
05/08/86	SJ23576	3.000	< .7	8.184	26	< 1	< .2	1.3	.8
05/15/86	SJ23705	3.591	< .7	8.797	< .2	< 1	< .2	.4	.2
05/22/86	SJ23834	1.531	< .7	6.321	< .2	< 1	< .2	.4	.2
05/29/86	SJ23947	2.756	< .7	7.807	< .2	< 1	< .2	< .1	< .1
06/05/86	SJ24100	3.041	< .7	8.060	40	< 1	< .2	1.2	.5
06/12/86	SJ24274	2.672	< .7	8.037 D	< .2	< 1	< .2	1.1	.2
06/19/86	SJ24501	2.531	< .8	7.878	< .2	< 1	< .2	.8	.4
06/26/86	SJ24675	< 1.000	< .5	8.234	< .1	< 1	< .2	.1	< .1
07/03/86	SJ24825	2.301	< .7	4.826 D	< .2	< 1	< .1	.4	< .1
07/10/86	SJ24985	1.699	< .7	5.909 D	< .2	< 1	< .2	.1	< .1
07/17/86	SJ25182	2.040 B	< .6 B	8.491	< .2 B	< 1 B	< .2	.1	< .1
07/24/86	SJ25334	3.415	< .7	7.848	< .2	< 1	< .2	< .1	< .1
07/31/86	SJ25573	3.857	< .6	8.716	35	< 1	< .2	.4	< .09
08/07/86	SJ25794	3.681	< .7	8.043	3.8	< 1	< .2	.5	< .1
08/14/86	SJ25992	2.431	< .7	7.869	< .2	< 1	< .2	.2	.2
08/21/86	SJ26169	< 1.000	< .6	6.982	< .1	< 1	< .1	< .1	< .1
08/28/86	SJ26347	< 1.301	< .6	5.505	< .2	< 1	< .2	.2	< .1
09/04/86	SJ26585	< 1.000	< .6	5.929 D	< .1	< 1	< .1	.1	< .1
09/11/86	SJ26680	2.415	< .6	7.940	110	< 1	< .2	.2	< .1
09/18/86	SJ26956	1.778	.6	8.204 D	< .2	< 1	< .2	.5	< .1
09/25/86	SJ27105	1.845	< .7	8.519	720	< 1	< .2	.2	< .1
10/02/86	SJ27466	3.000	< .6	8.000	6.7	< 1	< .2	.8	.1
10/09/86	SJ27447	3.114	< .6	8.991	640	< 1	< .1	1.2	.1
10/16/86	SJ27749	2.342	< .6	8.591	1	< 1	< .1	.3	< .1
10/23/86	SJ27944	2.000 B	< .7	8.624 B	.8 B	< 1 B	< .2	.2	< .1

TABLE C6 CONT'D. SITE: IX-A-4 BAGGED PRODUCT/RICE HULL MIX

* S A M P L E   T E S T   R E S U L T S *

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E.COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	VERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
10/30/86	SJ28163	1.301	< .6	9.041	< .2	< 1	< .2	.08	.08
11/06/86	SJ28410	< 1.000	< .6	7.431	< .1	< 1	< .1	< .08	< .08
11/13/86	SJ28479	< 1.301	< .6	8.991	< .2	< 1	< .2	.1	.1
11/26/86	SJ29027	< 1.000	< .5	7.929	< .1	< 1	< .1	< .1	< .1
12/04/86	SJ29375	< 1.000	< .6	8.663	< .1	< 1	< .1	< .08	< .08
12/11/86	SJ29386	< 1.000 D	< .6	8.732	< .1	< 1	< .1	< .1	< .1
12/18/86	SJ29587	< 1.301 D	< .6	9.079	1	< 1	< .1	< .1	< .1
12/31/86	SJ30400	< 1.301 D	< .7	8.342	< .2	< 1	< .2	.4	< .1
01/08/87	SJ30409	< 1.301 D	< .7	8.556	73	< 1	< .2	< .09	< .09
01/15/87	SJ30488	1.903 D	< .8	9.176	< .2	< 1	< .2	< .1	< .1
01/22/87	SJ30655	1.477 D	< .6	8.748	< .1	< 1	< .1	< .1	< .1

TABLE C6 CONT'D. SITE: IX-A-4 BAGGED PRODUCT/RICE HULL MIX

SAMPLE TEST RESULTS

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
01/16/86	SJ20445	< .1	.5	< .1	< .1	< .04
01/22/86	SJ20643	< .1	.4	< .1	< .1	< .04
01/30/86	SJ20814	< .2	1.2	< .2	< .2	< .05
02/06/86	SJ21048	< .1	.6	< .1	< .1	< .05
02/13/86	SJ21177	< .1	.3	< .1	< 1.1	< .05
02/20/86	SJ21293	< .2	1.7	< .2	< .2	< .06
02/27/86	SJ21418	< .2 B	2.0 B	.2 B	< .2 B	< .05
03/06/86	SJ21601	< .1	.7	< .1	< .1	< .05
03/13/86	SJ21784	< .2	.2	< .2	< .2	< .05
03/20/86	SJ21931	< .1	.3	< .1	.3	< .09
03/27/86	SJ22180	< .2	.8	< .2	.2	< .08
04/03/86	SJ22827	< .1	.1	< .1	< .1	< .07
04/10/86	SJ22605	< .1	.3	< .1	< .1	< .07
04/17/86	SJ22928	< .1 B	.6 B	< .1 B	< .1 B	< .07
04/24/86	SJ23128	< .1	.4	< .1	< .1	< .08
05/08/86	SJ23576	< .1	.5	< .1	< .1	< .06
05/15/86	SJ23705	< .1	.2	< .1	< .1	< .07
05/22/86	SJ23834	< .1	.1	.1	< .1	< .06
05/29/86	SJ23947	< .1	< .1	< .1	< .1	< .07
06/05/86	SJ24100	< .1	.6	< .1	.1	< .06
06/12/86	SJ24274	< .2	.9	< .2	< .2	< .06
06/19/86	SJ24501	< .1	.4	< .1	< .1	< .06
06/26/86	SJ24675	< .1	.1	< .1	< .1	< .06
07/03/86	SJ24825	< .1	.4	< .1	< .1	< .06
07/10/86	SJ24985	< .1	.1	< .1	< .1	< .07
07/17/86	SJ25182	< .1	< .1	< .1	.1	< .06
07/24/86	SJ25334	< .1	< .1	< .1	< .1	< .06
07/31/86	SJ25573	< .09	.4	< .09	< .09	< .05
08/07/86	SJ25794	< .1	.5	< .1	< .1	< .06
08/14/86	SJ25992	< .2	< .2	< .2	< .2	< .07
08/21/86	SJ26169	< .1	< .1	< .1	< .1	< .06
08/28/86	SJ26347	< .1	.1	< .1	.1	< .06
09/04/86	SJ26585	< .1	.1	< .1	< .1	< .06
09/11/86	SJ26680	< .1	< .1	.1	.1	< .06
09/18/86	SJ26956	< .1	.5	< .1	< .1	< .07
09/25/86	SJ27105	< .1	.2	< .1	< .1	< .06
10/02/86	SJ27466	< .1	.7	< .1	< .1	< .07
10/09/86	SJ27447	< .1	1	< .1	.1	< .06
10/16/86	SJ27749	< .1	.3	< .1	< .1	< .07
10/23/86	SJ27944	< .1	.2	< .1	< .1	< .06

TABLE C6 CONT'D. SITE: IX-A-4 BAGGED PRODUCT/RICE HULL MIX

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
10/30/86	SJ28163	< .08	< .08	< .08	< .08	< .06
11/06/86	SJ28410	< .08	< .08	< .08	< .08	< .06
11/13/86	SJ28479	< .1	< .1	< .1	< .1	< .06
11/26/86	SJ29027	< .1	< .1	< .1	< .1	< .05
12/04/86	SJ29375	< .08	< .08	< .08	< .08	< .06
12/11/86	SJ29386	< .1	< .1	< .1	< .1	< .05
12/18/86	SJ29587	< .1	< .1	< .1	< .1	< .06
12/31/86	SJ30400	< .1	.4	< .1	< .1	< .07
01/08/87	SJ30409	< .09	< .09	< .09	< .09	< .07
01/15/87	SJ30488	< .1	< .1	< .1	< .1	< .07
01/22/87	SJ30655	< .1	< .1	< .1	< .1	< .06

FOOTNOTE(S) :

B - AVERAGE OF DUPS
D - RETESTED
J - INTERFERENCE
M - UNIT = MPN/G

TABLE C7 SITE: IX-A-5 BAGGED PRODUCT/SAWDUST MIX

SAMPLE TEST RESULTS

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
01/18/86	SJ20446	57.2	8.415	7.875	7.623	9.279	8.114	4.637	4.182
01/23/86	SJ20642	55.8	6.887	6.887	6.429	9.308	7.285	3.432	3.172
01/30/86	SJ20815	43.2	7.333	7.333	7.333	9.606	8.023	3.171	2.856
02/06/86	SJ21049	45.6	7.703	7.703	7.971	9.268	8.239	3.192	2.295
02/13/86	SJ21178	46.6	6.965	6.965	7.693	10.768	9.293	4.511	4.531
02/20/86	SJ21294	46.5	8.301	7.966	6.966	9.788	9.460	4.344	4.589
02/27/86	SJ21419	51.0	7.654	7.261	6.654	8.655	7.678	4.647	4.456
03/06/86	SJ21602	46.5 B	7.657	7.134 B	6.587 B	9.898 B	8.751 B	> 5.124 B	3.931 B
03/13/86	SJ21785	51.8	7.647	7.647	7.919	9.824	8.543	4.697	3.688
03/20/86	SJ21932	40.6	8.360	8.360	6.360	9.520	7.988	3.663	3.177
03/27/86	SJ22181	42.0	3.010	3.010	4.968	8.836	8.990	4.698	2.678
04/03/86	SJ22828	59.7	8.400	8.400	6.400	9.498	8.069	5.668	> 5.140
04/10/86	SJ22606	50.1	9.269	7.175	3.269	10.133	9.486	4.804	4.381
04/17/86	SJ22929	51.0	8.926	8.654	7.261	9.872	9.872	5.035	4.493
04/24/86	SJ23129	51.0	8.926	8.654	7.654	9.516	9.316	5.407	4.486
04/30/86	SJ23308	51.7	7.555 B	7.359 B	6.399 B	9.332 B	7.304 B	2.812 B	2.530 B
05/08/86	SJ23577	58.3	8.109	7.868	7.109	9.369	7.994	3.467	4.317
05/15/86	SJ23706	53.6	8.239	7.904	6.633	9.471	8.258	3.619	3.709
05/22/86	SJ23835	52.5	7.642	7.642	5.913	9.363	7.335	4.087	3.476
05/29/86	SJ23948	55.1	7.892	7.892	8.227	9.098	8.318	3.568	3.512
06/07/86	SJ24101	60.2	7.189	7.189	6.854	8.859	8.203	3.591	1.903
06/12/86	SJ24275	60.7	6.850	6.850	6.579	9.181	8.466	4.204	3.176
06/19/86	SJ24502	61.0	4.843 D	4.848 D	6.183	8.699	7.443	2.954	5.301
06/26/86	SJ24676	64.8	7.851	7.157	7.157	8.846	7.651	4.146	4.114
07/03/86	SJ24826	64.1	7.827	7.827	7.573	9.197	8.883	4.708	4.301
07/10/86	SJ24986	53.4	6.449	6.148	6.906	9.167	6.778	3.716	3.978
07/17/86	SJ25183	64.6	4.823	4.158	5.551	8.727	7.132	3.114	3.176
07/24/86	SJ25335	65.7	4.927 B	4.927 B	6.087 B	8.983 B	7.862 B	3.531	3.204
07/31/86	SJ25574	67.3	5.140	5.140	6.348	9.181 D	8.231 D	3.491	3.447
08/07/86	SJ25795	57.2	.876	< .5 M	1.876	7.741	5.734	< 1.000	< 1.000
08/14/86	SJ25993	54.5	.897	< .6 M	1.625	8.330	6.403	3.079	4.079
08/21/86	SJ26170	68.7	< .4 M	< .4 M	2.146	7.342 D	6.690 D	< 1.000	< 1.000
08/28/86	SJ26348	61.0	4.398 D	4.398 D	3.806	8.000 D	7.176 D	< 1.000	< 1.000
09/04/86	SJ26586	58.2	5.869	5.869	4.602	8.000	7.279	3.114	3.176
09/11/86	SJ26681	61.0	6.398	5.176	4.845	9.079	7.322	2.792	2.732
09/18/86	SJ26957	60.3	5.176	5.176	5.813	8.732	8.491	2.982	1.845
09/25/86	SJ27106	63.4	4.380	3.833	6.079	8.785 D	6.204 D	< 1.000	< 1.000
10/02/86	SJ27467	65.0	5.079	5.079	6.146	8.531	7.519	< 1.000	< 1.000
10/09/86	SJ27448	64.1	5.176	4.556	5.176	8.653	5.531	2.398	1.477
10/16/86	SJ27750	58.0	5.602	5.602	5.204	8.724	7.602	2.279	2.000

TABLE C7 CONT'D. SITE: IX-A-5 BAGGED PRODUCT/SAWDUST MIX

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	TOTAL SOLIDS	TOTAL COLIFORM	FECAL COLIFORM	FECAL STREP	AEROBIC PLATE COUNT	ANAEROBIC PLATE COUNT	TOTAL FUNGI	THERMOPHILIC FUNGI
		%	LOGMPN/G	LOGMPN/G	LOGMPN/G	LOGCFU/G	LOGCFU/G	LOGCFU/G	LOGCFU/G
10/23/86	SJ27945	64.4	4.556	3.826	5.556	8.914	8.041	3.255	< 1.000
10/30/86	SJ28164	64.9	.8 B,M	< .5 B,M	3.362 B	8.201 B,D	7.041 B,D	< 1.000 B	< 1.000 B
11/06/86	SJ28411	60.3	4.398	3.079	4.851	8.255	7.146	2.301	2.255
11/13/86	SJ28480	59.7	4.398	4.398	4.857	8.415	7.279	2.000	2.000
11/26/86	SJ29028	55.9	5.886	5.431	4.886	9.204	5.505	> 5.771	2.362
12/04/86	SJ29376	55.4	4.892	4.623	6.230	9.041	6.204	4.505	4.204
12/11/86	SJ29387	61.8 B	5.845	5.845	7.176	9.079	7.826	2.623	2.591
12/18/86	SJ29588	45.1	5.519	4.322	4.519	9.176	6.079	4.580	2.301
12/31/86	SJ30401	50.6	5.929	4.653	4.929	8.903	8.633	3.301	3.362
01/08/87	SJ30410	53.5	7.633 D	4.903 D	5.230	9.146	7.531	4.799	3.415
01/15/87	SJ30489	65.1	5.544 D	5.544 D	4.146	8.398	6.079	< 1.000	< 1.000
01/22/87	SJ30656	50.9	5.255	5.255	5.924	9.000	8.447	3.114	3.079

TABLE C7 CONT'D. SITE: IX-A-5 BAGGED PRODUCT/SAWDUST MIX

SAMPLE TEST RESULTS

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	VERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
01/16/86	SJ20446	4.357	< .7	9.079	160	< 1	< .2	.4	.1
01/23/86	SJ20642	5.759	< .7	9.076	.5	< 1	< .2	.7	.1
01/30/86	SJ20815	4.535	< .9	9.524	53	< 1	2	.7	.2
02/06/86	SJ21049	3.378	< .9	9.270	50	< 1	< .2	2.1	1.1
02/13/86	SJ21178	5.407	< .9	10.371	32	< 1	< .2	.2 D	.1 D
02/20/86	SJ21294	3.795	< .9	9.442	92	< 1	2.4	2.5	.7
02/27/86	SJ21419	4.690	< .8	8.279	84	< 1	< .2	2.5	1.2
03/06/86	SJ21602	4.686	< .9	8.262 B	71	< 1 B	< .2 B	.6 B	.2 B
03/13/86	SJ21785	4.763	< .8	9.197	29	< 1	< .2	1.0	.3
03/20/86	SJ21932	5.301	< 1	8.897	57	< 1	< .3	1.6	.7
03/27/86	SJ22181	3.653	< 1	6.691	< .2	< 1	< .2	2.2	1.0
04/03/86	SJ22828	4.869	< .7	8.804	160	< 1	< .2	.3	< .1
04/10/86	SJ22606	3.398	< .8	9.451	1900	< 1	< .2	.6	.3
04/17/86	SJ22929	4.708	< .8	9.150	1800	< .1	< .2	2	1
04/24/86	SJ23129	5.255	< .8	9.198	15	< 1	< .2	3	2
04/30/86	SJ23308	3.398 B	< .8	8.087 B	640 B	< 1 B	< .2 B	4	2
05/08/86	SJ23577	3.204	< .7	8.681	36	< 1	< .2	1.4	.4
05/15/86	SJ23706	4.041	< .8	8.904	170	< 1	< .2	.8	.1
05/22/86	SJ23835	3.279	< .6	7.785	8800	< 1	< .2	1.4	.5
05/29/86	SJ23948	2.114	< .7	8.809	170	< 1	< .2	1.3	.3
06/05/86	SJ24101	3.342	< .7	7.523 D	71	< 1	< .2	1.2	.4
06/12/86	SJ24275	4.398	< .7	8.112	38	< 1	< .2	.8	.1
06/19/86	SJ24502	1.477	< .7	7.848	< .2	< 1	< .2	.4	.1
06/26/86	SJ24676	3.462	1.8	8.469	14	< 1	< .2	1.1	.2
07/03/86	SJ24826	6.176	< .6	8.331	15	< 1	< .2	.8	.2
07/10/86	SJ24986	3.690	< .8	8.954	< .2	< 1	< .2	1.3	.3
07/17/86	SJ25183	2.778	< .6	7.982	.2	< 1	< .2	< .1	< .1
07/24/86	SJ25335	3.793 B	< .6 B	8.889 B	50 B	< 1	< .2 B	.7 B	< .05 B
07/31/86	SJ25574	3.415	< .6	8.187	340	< 1	< .2	.38	.08
08/07/86	SJ25795	< 1.301	< .7	6.983	< .2	< 1	< .2	1	< .1
08/14/86	SJ25993	1.301	< .7	8.164	< .2	< 1	< .2	.9	.2
08/21/86	SJ26170	< 1.000	< .6	7.041	< .1	< 1	< .1	.8	< .2
08/28/86	SJ26348	< 1.301	< .7	7.462	< .2	< 1	< .2	.8	< .1
09/04/86	SJ26586	< 1.301	< .7	8.230	1600	< 1	< .2	.9	< .1
09/11/86	SJ26681	2.322	< .7	8.322	70	< 1	< .2	.4	.2
09/18/86	SJ26957	< 1.301	< .7	8.415	< .2	< 1	< .2	2	< .1
09/25/86	SJ27106	2.778	< .6	7.342 D	1	< 1	< .2	.2	< .1
10/02/86	SJ27467	< 1.301	< .6	8.813	< .2	< 1	< .2	1	< .1
10/11/86	SJ27448	2.000	< .6	8.255	< .2	< 1	< .2	.8	.3
10/16/86	SJ27750	2.000	< .7	8.643	74	< 1	< .2	2	< .1

TABLE C7 CONT'D.   SITE:IX-A-5   BAGGED PRODUCT/SAWDUST MIX

SAMPLE TEST RESULTS

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	VERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
10/23/86	SJ27945	2.301	< .6	8.079	.2	< 1	< .2	.5	< .1
10/30/86	SJ28164	< 1.301 B	< .6 B	8.055 B	< .2 B	< 1 B	< .2	.07 B	< .05 B
11/06/86	SJ28411	< 1.301	< .7	8.531 D	< .2	< 1	< .2	< .1	< .1
11/13/86	SJ28480	1.301	< .7	8.322	< .2	< 1	< .2	< .09	< .09
11/26/86	SJ29028	1.602	< .7	8.748	< .2	< 1	< .2	.6	.1
12/04/86	SJ29376	1.845	< .7	8.114	780	< 1	< .2	.1	< .1
12/11/86	SJ29387	2.279 D	< .6	8.580	.6	< 1	< .2	.5	< .1
12/18/86	SJ29588	< 1.301 D	< .9	8.230	95	< 1	< .2	.2	< .2
12/31/86	SJ30401	2.447 D	< .8	8.740	< .2	< 1	< .2	.9	< .2
01/08/87	SJ30410	3.079 D	< .8	8.820	28	< 1	< .2	< .1	< .1
01/15/87	SJ30489	< 1.301	< .6	8.342	1	< 1	< .2	< .1	< .1
01/22/87	SJ30656	1.602 D	< .8	8.230	< .2	< 1	< .2	< .1	< .1

TABLE C7 CONT'D. SITE: IX-A-5 BAGGED PRODUCT/SAWDUST MIX

* SAMPLE TEST RESULTS *

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
01/16/86	SJ20446	< .1	.3	< .1	< .1	< .04
01/23/86	SJ20642	< .1	.5	< .2	< .2	< .05
01/30/86	SJ20815	< .2	.5	< .2	< .2	< .06
02/06/86	SJ21049	< .2	1.0	< .2	< .2	< .06
02/13/86	SJ21178	< .1 D	.1 D	< .1 D	< .1 D	< .05
02/20/86	SJ21294	< .2	1.8	< .2	< .2	< .05
02/27/86	SJ21419	< .1	1.3	< .1	< .1	< .05
03/06/86	SJ21602	< .2 B	.4 B	< .2 B	< .2 B	< .05
03/13/86	SJ21785	< .1	.7	< .1	< .1	< .05
03/20/86	SJ21932	< .2	.9	< .2	< .2	< .08
03/27/86	SJ22181	< .2	.7	< .2	.5	< .09
04/03/86	SJ22828	< .1	< .1	.3	< .1	< .06
04/10/86	SJ22606	< .1	.3	< .1	< .1	< .07
04/17/86	SJ22929	< .1	1	< .1	< .1	< .08
04/24/86	SJ23129	< .1	1	< .1	< .1	< .07
04/30/86	SJ23308	< .1	4	< .1	< .1	< .07
05/08/86	SJ23577	< .1	1	< .1	< .1	< .06
05/15/86	SJ23706	< .1	.7	< .1	< .1	< .07
05/22/86	SJ23835	< .1	.9	< .1	< .1	< .06
05/29/86	SJ23948	< .1	1	< .1	< .1	< .07
06/05/86	SJ24101	< .1	.7	< .1	.1	< .06
06/12/86	SJ24275	< .1	.7	< .1	< .1	< .06
06/19/86	SJ24502	< .1	.3	< .1	< .1	< .06
06/28/86	SJ24676	< .1	.9	< .1	< .1	< .06
07/03/86	SJ24826	< .1	.6	< .1	< .1	< .06
07/10/86	SJ24986	< .1	1	< .1	< .1	< .08
07/17/86	SJ25183	< .1	< .1	< .1	< .1	< .07
07/24/86	SJ25335	< .05 B	.7 B	< .05 B	< .05 B	< .06 B
07/31/86	SJ25574	< .08	.3	< .08	< .08	< .07
08/07/86	SJ25795	< .1	1	< .1	< .1	< .07
08/14/86	SJ25993	< .2	.7	< .2	< .2	< .07
08/21/86	SJ26170	< .2	.8	< .2	< .2	< .06
08/28/86	SJ26348	< .1	.8	< .1	< .1	< .06
09/04/86	SJ26586	< .1	.9	< .1	< .1	< .09
09/11/86	SJ26681	< .1	.2	< .1	< .1	< .08
09/18/86	SJ26957	< .1	2	< .1	< .1	< .06
09/25/86	SJ27106	< .1	.2	< .1	< .1	> .06 A
10/02/86	SJ27467	< .1	1	< .1	< .1	< .06
10/09/86	SJ27448	< .09	.5	< .09	< .09	< .06
10/16/86	SJ27750	< .1	2	< .1	< .1	< .08

TABLE C7 CONT'D. SITE: IX-A-5 BAGGED PRODUCT/SAWDUST MIX

• SAMPLE TEST RESULTS •

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
10/23/86	SJ27945	< .1	.5	< .1	< .1	< .06
10/30/86	SJ28164	< .05 B	.07 B	< .05 B	< .05 B	< .06 B
11/06/86	SJ28411	< .1	< .1	< .1	< .1	< .06
11/13/86	SJ28480	< .09	< .09	< .09	< .09	< .06
11/26/86	SJ29028	< .1	.5	< .1	< .1	< .07
12/04/86	SJ29376	< .1	.1	< .1	< .1	< .07
12/11/86	SJ29387	< .1	.5	< .1	< .1	< .06
12/18/86	SJ29588	< .2	.2	< .2	< .2	< .08
12/31/86	SJ30401	< .2	.9	< .2	< .2	< .08
01/08/87	SJ30410	< .1	< .1	< .1	< .1	< .07
01/15/87	SJ30489	< .1	< .1	< .1	< .1	< .06
01/22/87	SJ30656	< .1	< .1	< .1	< .1	< .08

FOOTNOTE(S) :

A - POSSIBLE CONTAMINATION BY SPIKE
B - AVERAGE OF DUPS
D - RETESTED
M - UNIT = MPN/G

TABLE C8 SITE: IX-A-6 BAGGED PRODUCT/MULTIPLE MIX

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
01/23/86	SJ20648	54.4	8.898	8.898	7.626	9.913	9.345	4.645	4.547
01/30/86	SJ20816	56.6	8.881	8.609	6.881	9.785	9.171	4.546	3.387
02/06/86	SJ21050	53.6	8.633	8.633	7.904	9.845	9.296	5.296	5.074
02/13/86	SJ21179	58.2	7.204	6.868	7.204	9.587	8.009	4.364	3.768
02/20/86	SJ21295	61.3	6.574	5.574	7.181	9.796	8.121	> 5.690	2.116
02/27/86	SJ21420	41.1	7.562	7.355	6.748	8.725	8.089	> 3.386 J	5.556
03/06/86	SJ21603	56.1	8.427	8.220	7.884	9.543	9.054	3.251	4.031
03/13/86	SJ21786	54.8	8.491 B	8.491 B	8.895 B	9.652 B	8.484 B	4.898 B	4.706 B
03/20/86	SJ21933	56.5	7.881	7.424	6.424	9.822	9.354	4.981	5.152
03/27/86	SJ22182	57.6	9.208	8.873	7.208	10.085	9.564	5.416	5.409
04/03/86	SJ22829	56.0	9.220	9.220	7.220	9.890	9.166	4.731	4.843
04/10/86	SJ22607	58.1	7.598	7.598	6.598	9.481	9.287	3.257	3.244
04/17/86	SJ22930	56.9	8.213	8.213	7.213	9.283	8.270	4.537	4.352
04/24/86	SJ23130	60.6	8.186	8.186	6.851	9.354	8.243	4.340	4.172
04/30/86	SJ23309	60.1	9.884 D	9.884 D	8.096	9.584	9.399	4.000	3.929
05/08/86	SJ23578	58.9 B	8.031 B	8.031 B	7.198 B	9.589 B	8.077 B	4.084 B	3.659 B
05/15/86	SJ23707	56.9	8.607	8.607	8.213	9.586	9.129	5.146	5.020
05/22/86	SJ23836	53.0	7.637	7.637	6.909	9.929	8.085	4.376	3.867
05/29/86	SJ23949	57.6	8.873	8.873	7.873	9.430	8.544	4.465	4.144
06/06/86	SJ24102	59.5	9.194	9.194	8.548	9.314 D	8.590 D	2.653	3.940
06/12/86	SJ24276	60.5	8.852	8.852	7.852	9.913	9.135	3.954	4.000
06/19/86	SJ24503	62.6	7.172	7.172	5.565	9.010	7.482	3.556	3.380
06/26/86	SJ24677	54.4	7.855	7.855	5.898	9.165	7.827	3.708	3.672
07/03/86	SJ24827	51.1	7.925	7.925	7.468	9.694	8.700	3.869	3.643
07/10/86	SJ24987	53.0	7.637	7.244	7.452	9.342	8.054	4.681	4.663
07/17/86	SJ25184	70.1	6.516	6.516	7.788	9.368	7.423	4.079	4.279
07/24/86	SJ25336	62.2	7.568	7.568	7.840	8.490	7.398	3.771	3.602
07/31/86	SJ25575	64.0	4.827	4.556	5.556	9.420	6.617	5.416	< 1.000
08/07/86	SJ25796	61.3	5.080 B	4.712 B	5.212 B	8.355 B	5.924 B	< 1.000	< 1.000
08/14/86	SJ25994	63.4	4.831	3.831	4.831	9.627	7.004	> 5.672	2.505
08/21/86	SJ26171	62.0	4.176	3.568	4.079	9.255	6.000	6.681	< 1.000
08/28/86	SJ26349	65.9	6.146	6.146	5.505	8.690	7.380	< 1.000	< 1.000
09/04/86	SJ26587	68.4	1.799 D	< .4 D.M	3.799	8.820	7.415	< 1.000	< 1.000
09/11/86	SJ26682	57.7	6.204 D	4.875 D	2.602 D	9.041	7.204	4.505	4.462
09/18/86	SJ26958	64.5	4.826	4.826	2.556	8.544	7.114	4.690	4.785
09/25/86	SJ27107	64.7	4.146	3.556	4.556	9.255	6.079	4.000	4.491
10/02/86	SJ27468	66.0	6.845	6.556	6.771 D	8.699	8.079	2.763	2.785
10/09/86	SJ27449	69.1	2.792	1.519	3.792	9.041	7.949	6.462	5.580
10/16/86	SJ27751	57.4	4.623	4.204	5.204	9.000	6.146	5.362	3.398
10/23/86	SJ27946	62.4	2.176	1.839	3.839	8.978	8.398	1.778	2.000

TABLE C8 CONT'D. SITE: IX-A-6   BAGGED PRODUCT/MULTIPLE MIX

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
10/30/86	SJ28165	61.6	4.380	4.380	4.845	9.491	8.898	5.623	2.255
11/06/86	SJ28412	63.4	4.905 B	4.378 B	4.833 B	8.370 B,D	7.562 B,D	2.699 B	1.699 B
11/13/86	SJ28481	60.8	5.079	5.079	5.176	9.255	6.398	2.708	3.851
11/26/86	SJ29029	62.9	8.519	8.519	7.568	9.580	8.491	3.820	4.477
12/04/86	SJ29377	57.6	6.602	6.602	6.415	9.230	6.724	2.839	2.771
12/11/86	SJ29388	58.1	5.869	5.869	6.602	9.531	8.959	4.591	3.556
12/18/86	SJ29589	57.3	7.602	6.875	6.204	9.462	7.301	4.146	4.204
12/31/86	SJ30402	63.4	5.176	5.176	4.380 D	9.342 D	6.519 D	6.079	3.643
01/08/87	SJ30411	56.4	5.613	5.204	5.114	9.602	8.653	4.114	3.362
01/15/87	SJ30490	60.1	7.176	7.176	6.176	8.973	7.079	2.875	2.833
01/22/87	SJ30657	59.6	5.398	5.204	5.591	8.908	6.322	1.699	1.477

TABLE C8 CONT'D. SITE: IX-A-6 BAGGED PRODUCT/MULTIPLE MIX

* SAMPLE TEST RESULTS *

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	VERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
01/23/86	SJ20648	5.704	< .7	9.573	390	< 1	< .2	1.8	.8
01/30/86	SJ20816	4.694	< .7	9.574	16000	< 1	< .2	.6	< .1
02/06/86	SJ21050	5.561	< .8	9.457	800	< 1	.6	.5	.1
02/13/86	SJ21179	3.164	< .7	9.101	740	< 1	< .2	.8	.5
02/20/86	SJ21295	2.744	< .7	9.535	70	< 1	< .2	1.5	.1
02/27/86	SJ21420	4.833	< 1	8.237	51	< 1	< .2	2.5	.5
03/06/86	SJ21603	4.914	< .7	9.054	4.1	< 1	< .2	.9	.4
03/13/86	SJ21786	5.319	< .7	9.361 B	93 B	< 1	< .2 B	.8 B	.2 B
03/20/86	SJ21933	3.919	< .7	9.355	< .2	< 1	< .2	1.0	< .1
03/27/86	SJ22182	4.255	< .7	9.717	4200	< 1	< .2	.5	.4
04/03/86	SJ22829	5.491	< .7	9.269	4300	< 1	< .2	.9	.4
04/10/86	SJ22607	3.279	< .7	9.368	.2	< 1	< .2	.5	.1
04/17/86	SJ22930	5.041	< .7	9.176	760	< 1	< .2	1.1	.1
04/24/86	SJ23130	4.230	< .7	8.803	48	< 1	< .2	1.5	.5
04/30/86	SJ23309	5.477	< .7	9.340	1500	< 1	< .2	.8	.2
05/08/86	SJ23578	3.845 B	< .7	9.056 B	.7 B	< 1 B	< .2 B	.9 B	< .1 B
05/15/86	SJ23707	3.934	< .7	9.282	160	< 1	< .2	.2	.1
05/22/86	SJ23836	2.806	.8	8.814	810	< 1	< .2	.8	< .1
05/29/86	SJ23949	3.929	< .7	8.771 D	400	< 1	< .2	1.0	.1
06/05/86	SJ24102	4.462	< .7	8.757 D	1600	< 1	< .2	1.1	.2
06/12/86	SJ24276	3.672	< .7	9.110	1500	< 1	< .2	.6	.4
06/19/86	SJ24503	2.839	< .6	7.821	69	< 1	< .2	.6	.1
06/26/86	SJ24677	3.491	< .7	8.308	< .2	< 1	< .2	.4	.1
07/03/86	SJ24827	5.964	< .8	8.860	15	< 1	< .2	1.1	.1
07/10/86	SJ24987	4.602	< .8	8.309	4500	< 1	< .2	.8	< .1
07/17/86	SJ25184	4.568	< .6	8.798	.1	< 1	< .1	.1	< .1
07/24/86	SJ25336	3.176	< .6	8.271	370	< 1	< .2	.5	< .1
07/31/86	SJ25575	2.806	< .6	8.340	< .2	< 1	< .2	.2	< .1
08/07/86	SJ25796	1.952 B	< .6 B	8.113 B	< .2 B	< 1 B	< .2 B	.6 B	< .05 B
08/14/86	SJ25994	< 1.301	< .6	8.443	< .2	< 1	< .2	.1	< .1
08/21/86	SJ26171	< 1.301	< .6	8.519	< .2	< 1	< .2	.3	< .1
08/28/86	SJ26349	2.000	< .6	7.845	< .2	< 1	< .2	.4	< .08
09/04/86	SJ26587	< 1.000	< .6	8.279	< .1	< 1	< .1	< .1	< .1
09/11/86	SJ26682	1.301	< .7	8.230	< .2	< 1	< .2	< .1	< .1
09/18/86	SJ26958	< 1.301	< .6	7.892 D	< .2	< 1	< .2	< .09	< .09
09/25/86	SJ27107	1.301	< .6	8.591	< .2	< 1	< .2	< .1	< .1
10/02/86	SJ27468	3.398	< .6	8.230	65	< 1	< .2	< .1	< .1
10/09/86	SJ27449	1.000	< .7	8.114	< .1	< 1	< .1	.38	< .08
10/16/86	SJ27751	2.491	< .7	8.301	400	< 1	< .2	.5	.1
10/23/86	SJ27946	2.000	< .6	8.176	< .2	< 1	< .2	.6	< .1

TABLE C8 CONT'D. SITE: IX-A-6 BAGGED PRODUCT/MULTIPLE MIX

SAMPLE TEST RESULTS

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	YERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
10/30/86	SJ28165	2.000	< .6	8.851	< .2	< 1	< .2	.09	< .09
11/06/86	SJ28412	1.500 B	< .6 B	7.826 B	3 B	< 1 B	< .2 B	.09 B	< .05 B
11/13/86	SJ28481	2.000	< .7	9.204	< .2	< 1	< .2	.4	< .1
11/26/86	SJ29029	4.820 D	< .6	9.114	680	< 1	< .2	.4	.1
12/04/86	SJ29377	1.301	< .7	8.771	400	< 1	< .2	.1	< .1
12/11/86	SJ29388	1.954 D	< .7	8.903	40	< 1	< .2	1.2	.2
12/18/86	SJ29589	3.114 D	< .7	9.415	2	< 1	< .2	.3	.3
12/31/86	SJ30402	2.322 D	< .6	8.633	< .2	< 1	< .2	.09	< .09
01/08/87	SJ30411	2.431 D	< .7	8.602	.2	< 1	< .2	< .1	< .1
01/15/87	SJ30490	1.845 D	< .7	8.591	15	< 1	< .2	< .09	< .09
01/22/87	SJ30657	< 1.301 D	.7	8.477	< .2	< 1	< .2	< .1	< .1

TABLE C8 CONT'D. SITE: IX-A-6 BAGGED PRODUCT/MULTIPLE MIX

* S A M P L E T E S T R E S U L T S * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
01/23/86	SJ20648	< .1	1	< .1	< .1	< .05
01/30/86	SJ20816	< .1	.6	< .1	< .1	< .04
02/06/86	SJ21050	< .1	.4	< .1	< .1	< .05
02/13/86	SJ21179	< .1	.3	< .1	< .1	< .04
02/20/86	SJ21295	< .1	1.2	< .1	.1	< .04
02/27/86	SJ21420	< .2	2	< .2	< .2	< .06
03/06/86	SJ21603	< .1	.5	< .1	< .1	< .05
03/13/86	SJ21786	< .1 B	.5 B	< .1 B	.1 B	< .05
03/20/86	SJ21933	< .1	1.0	< .1	< .1	< .06
03/27/86	SJ22182	< .1	.1	< .1	< .1	< .07
04/03/86	SJ22829	< .1	.5	< .1	< .1	< .09
04/10/86	SJ22607	< .1	.2	< .1	.1	< .06
04/17/86	SJ22930	< .1	1	< .1	< .1	< .06
04/24/86	SJ23130	< .1	1	< .1	< .1	< .07
04/30/86	SJ23309	< .1	.6	< .1	< .1	< .07
05/08/86	SJ23578	< .1 B	.9 B	< .1 B	< .1 B	> .03
05/15/86	SJ23707	< .1	.1	< .1	< .1	< .07
05/22/86	SJ23836	< .1	.8	< .1	< .1	< .07
05/29/86	SJ23949	< .1	.6	< .1	.3	< .06
06/05/86	SJ24102	< .1	.9	< .1	< .1	< .06
06/12/86	SJ24276	< .1	.2	< .1	< .1	< .06
06/19/86	SJ24503	< .1	.5	< .1	< .1	< .06
06/26/86	SJ24677	< .1	.3	< .1	< .1	< .07
07/03/86	SJ24827	< .1	1	< .1	< .1	< .09
07/10/86	SJ24987	< .1	.8	< .1	< .1	< .18
07/17/86	SJ25184	< .1	.1	< .1	< .1	< .06
07/24/86	SJ25336	< .1	.5	< .1	< .1	< .07
07/31/86	SJ25575	< .1	.2	< .1	< .1	< .07
08/07/86	SJ25796	< .05 B	.6 B	< .05 B	< .05 B	< .06
08/14/86	SJ25994	< .1	.1	< .1	< .1	< .06
08/21/86	SJ26171	< .1	.3	< .1	< .1	< .06
08/28/86	SJ26349	< .08	.4	< .08	< .08	< .07
09/04/86	SJ26587	< .1	< .1	< .1	< .1	< .05
09/11/86	SJ26682	< .1	< .1	< .1	< .1	> .07 A
09/18/86	SJ26958	< .09	< .09	< .09	< .09	< .06
09/25/86	SJ27107	< .1	< .1	< .1	< .1	< .06
10/02/86	SJ27468	< .1	< .1	< .1	< .1	< .06
10/09/86	SJ27449	< .08	.3	< .08	.08	< .06
10/16/86	SJ27751	< .1	.4	< .1	< .1	< .07
10/23/86	SJ27946	< .1	.6	< .1	< .1	< .06

TABLE C8 CONT'D. SITE: IX-A-6 BAGGED PRODUCT/MULTIPLE MIX

SAMPLE TEST RESULTS

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
10/30/86	SJ28165	< .09	.09	< .09	< .09	< .06
11/06/86	SJ28412	< .05 B	< .09 B	< .05 B	< .05 B	< .06 B
11/13/86	SJ28481	< .1	.4	< .1	< .1	< .07
11/26/86	SJ29029	< .1	.3	< .1	< .1	< .06
12/04/86	SJ29377	< .1	< .1	< .1	.1	< .07
12/11/86	SJ29388	< .1	.9	.1	< .1	< .07
12/18/86	SJ29589	< .1	< .1	< .1	< .1	< .07
12/31/86	SJ30402	< .09	.09	< .09	< .09	< .06
01/08/87	SJ30411	< .1	< .1	< .1	< .1	< .07
01/15/87	SJ30490	< .09	< .09	< .09	< .09	< .06
01/22/87	SJ30657	< .1	< .1	< .1	< .1	< .06

FOOTNOTE(S) :

A - POSSIBLE CONTAMINATION BY SPIKE
B - AVERAGE OF DUPS
D - RETESTED
J - INTERFERENCE
M - UNIT = MPN/G

TABLE C9 SITE: I-B-1

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
04/28/86	SJ23312	36.7	1.611	1.611	1.310	7.616	7.488	< 1.280	< 1.280
06/23/86	SJ24681	65.6	2.817	1.505	< .5 M	7.860	7.202	4.255	3.041
08/18/86	SJ26174	51.2	3.653	2.462	.924	7.778	6.799	4.041	4.491
10/14/86	SJ27754	31.2 B	2.477	1.681	2.477	7.079 D	6.568 D	2.785	< 1.301
12/22/86	SJ29592	35.3	4.833 B	2.915 B	3.813 B	8.486 B	7.494 B	4.996 B	3.875 B
02/18/87	SJ31478	32.2	4.462	3.114	3.462	9.255 D	8.531 D	2.875	2.301

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	YERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
04/28/86	SJ23312	1.431	< 1	6.404	< .3	< 1	< .3	.2	< .2
06/23/86	SJ24681	< 1.301	< .6	6.774	< .2	< 1	< .2	.2	.2
08/18/86	SJ26174	< 1.301	< .8	6.301	< .2	< 1	.2	.4	.4
10/14/86	SJ27754	< 1.477	< 1	6.462	< .3	< 1	< .3	.4	.2
12/22/86	SJ29592	< 1.477 B	< 1 B	7.403 B	< .3 B	< 1 B	.6 B	< .1 B	< .1 B
02/18/87	SJ31478	< 1.477	< 1	8.462	< .3	< 1	< .3	< .2	< .2

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
04/28/86	SJ23312	< .2	.2	< .2	< .2	< .09
06/23/86	SJ24681	< .1	< .1	< .1	< .1	< .05
08/18/86	SJ26174	< .2	< .2	< .2	< .2	< .07
10/14/86	SJ27754	< .2	.2	< .2	< .2	< .1
12/22/86	SJ29592	< .1 B	< .1 B	< .1 B	< .1 B	< .1
02/18/87	SJ31478	< .2	< .2	< .2	< .2	< .1

FOOTNOTE(S) :

B - AVERAGE OF DUPS
D - RETESTED
M - UNIT = MPN/G

TABLE C10 SITE: II-C-1

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
04/28/86	SJ23313	49.3	1.941	1.669	4.276	8.570	7.051	2.453	< 1.152
06/25/86	SJ24682	74.2	4.098	3.491	5.171	7.216	6.698	1.602	4.380
08/21/86	SJ26176	54.1	.898	.301	1.447 D	7.851	7.806	< 1.000	< 1.000
10/14/86	SJ27755	66.2	.6 M	.6 M	< .5 M	6.799	6.863	5.833	> 4.653
12/26/86	SJ30414	53.2	3.633	3.633	4.653	7.763	7.924	< 1.000	4.681
03/16/87	SJ32245	53.9	.5 B,M	< .3 B,M	< .3 B,M	5.130 B,D	4.929 B,D	< 1.000 B	< 1.000 B

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	YERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
04/28/86	SJ23313	1.613	< .8	6.040	< .2	< 1	< .2	< .1	< .1
06/25/86	SJ24682	< 1.000	< .5	5.505	< .1	< 1	< .1	< .07	< .07
08/21/86	SJ26176	< 1.301	< .7	< 3.255	< .2	< 1	< .2	< .2	< .2
10/14/86	SJ27755	< 1.301	< .6	4.826 D	< .2	< 1	< .2	< .1	< .1
12/26/86	SJ30414	3.431	< .8	9.279 D	810	< 1	< .2	< .1	< .1
03/16/87	SJ32245	< 1.301 B	< .4 B	< 1.000 B,D	< .1 B	< 1 B	< .1 B	.1 B	.1 B

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
04/28/86	SJ23313	< .1	< .1	< .1	< .1	< .07
06/25/86	SJ24682	< .07	< .07	< .07	< .07	< .05
08/21/86	SJ26176	< .2	< .2	< .2	< .2	< .07
10/14/86	SJ27755	< .1	< .1	< .1	< .1	< .06
12/26/86	SJ30414	< .1	< .1	< .1	< .1	< .08
03/16/87	SJ32245	< .05 B	< .05 B	< .05 B	< .05 B	< .08

FOOTNOTE(S) :

B - AVERAGE OF DUPS
D - RETESTED
M - UNIT = MPN/G

TABLE C11 SITE: III-B-3

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
04/21/86	SJ23133	58.8	3.199	3.199	2.592	9.128 D	5.372 D	< 1.076	2.407
06/16/86	SJ24507	69.0	1.130	< .4 M	1.342	7.994	5.666	2.279	2.000
08/11/86	SJ25997	56.4	2.613	< .5 M	2.613	8.799	7.716	2.477	2.903
10/06/86	SJ27452	69.3	3.114	.792	4.544	8.756 D	7.342 D	3.462	3.663
12/08/86	SJ29391	60.1	2.544	.000	5.602	8.591	7.342	4.301	< 1.000
02/09/87	SJ31374	60.2	.7 M	< .5 M	.000	8.613	7.519	< 1.000	< 1.000

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	YERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
04/21/86	SJ23133	1.230	< .7	7.998	< .2	< 1	< .2	.9	.8
06/16/86	SJ24507	< 1.000	< .6	6.693	< .1	< 1	< .1	< .1	< .1
08/11/86	SJ25997	< 1.301	< .7	7.672	< .2	< 1	< .2	< .1	< .1
10/06/86	SJ27452	< 1.000	< .6	7.301	< .1	< 1	< .1	< .1	< .1
12/08/86	SJ29391	< 1.301	< .7	7.000	< .2	< 1	< .2	< .1	< .1
02/09/87	SJ31374	< 1.301	< .7	6.000	< .2	< 1	< .2	< .1	< .1

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
04/21/86	SJ23133	< .1	< .1	.1	< .1	< .06
06/16/86	SJ24507	< .1	< .1	< .1	< .1	< .06
08/11/86	SJ25997	< .1	< .1	< .1	< .1	< .07
10/06/86	SJ27452	< .1	< .1	< .1	< .1	< .06
12/08/86	SJ29391	< .1	< .1	< .1	< .1	< .06
02/09/87	SJ31374	< .1	< .1	< .1	< .1	< .07

FOOTNOTE(S) :

D - RETESTED
M - UNIT = MPN/G

TABLE C12 SITE: III-B-4

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
05/05/86	SJ23583	49.5	2.939	1.628	4.939	7.843	6.288	2.260	< 1.150
06/30/86	SJ24830	62.3	5.567	4.382	7.174	9.900	8.900	5.204	4.079
09/02/86	SJ26592	57.6	5.875	4.602	2.602 D	8.973 D	8.934 D	< 1.000	1.477
10/21/86	SJ27949	61.3	4.176	3.845	7.176 D	9.544	7.176	5.146	4.653
12/30/86	SJ30405	52.6 B	7.322	6.940	6.914	9.740	8.740	3.996	4.255
02/23/87	SJ31633	46.9	6.809 B	6.053 B	6.301 B	10.060 B	8.947 B	4.716 B	4.785 B

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	VERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
05/05/86	SJ23583	1.301	< .8	7.718	< .2	< 1	< .2	.7	.7
06/30/86	SJ24830	< 1.301	< .6	7.973	< .2	< 1	< .2	< .1	< .1
09/02/86	SJ26592	< 1.301	2.1	8.146	< .2	< 1	< .2	< .1	< .1
10/21/86	SJ27949	< 1.301	< .6	7.114	< .2	< 1	< .2	.1	< .1
12/30/86	SJ30405	3.531	< .8	8.531	.8	< 1	< .2	< .1	< .1
02/23/87	SJ31633	2.330 B	< .5 B	8.477 B	< .2 B	< 1 B	.4 B	.2 B	< .1 B

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
05/05/86	SJ23583	< .1	< .1	< .1	< .1	< .07
06/30/86	SJ24830	< .1	< .1	< .1	< .1	< .05
09/02/86	SJ26592	< .1	< .1	< .1	< .1	< .06
10/21/86	SJ27949	< .1	.1	< .1	< .1	< .06
12/30/86	SJ30405	< .1	< .1	< .1	< .1	< .07
02/23/87	SJ31633	< .1 B	< .1 B	.2 B	< .1 B	< .08

FOOTNOTE(S) :

B - AVERAGE OF DUPS
D - RETESTED

TABLE C13 SITE: III-J-1

SAMPLE TEST RESULTS

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
05/29/86	SJ23950	61.9	2.177	2.177	2.613 B	8.419	6.153	< 1.053	< 1.053
07/21/86	SJ25339	63.0	< .5 M	< .5 M	3.523	7.933	6.726	3.079	3.176
09/15/86	SJ26963	70.6	2.114	1.322	3.041	8.079	5.672	2.643	2.708
11/10/86	SJ28485	57.0	< .5 M	< .5 M	4.602	8.613	6.176	< 1.000	1.699
01/20/87	SJ30660	60.3	.000	< .5 M	.851	8.568	5.732	1.477	< 1.000
03/16/87	SJ32246	89.1	.681	< .3 M	1.643	8.672	7.146	2.322	< .903

SAMPLE TEST RESULTS

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	YERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
05/29/86	SJ23950	1.407 B	< .7	6.842	< .2 B	< 1 B	< .2 B	.9 B	.1 B
07/21/86	SJ25339	< 1.301	< .6	6.289	< .2	< 1	< .2	.3	< .1
09/15/86	SJ26963	< 1.000	< .6	6.415	< .1	< 1	< .1	.8	< .1
11/10/86	SJ28485	< 1.301	< .7	7.362	< .2	< 1	< .2	.1	< .1
01/20/87	SJ30660	< 1.301	< .7	6.362	< .2	< 1	< .2	.1	.1
03/16/87	SJ32246	< 1.000 D	< .4	6.398	< .1	< 1	< .1	.06	.06

SAMPLE TEST RESULTS

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
05/29/86	SJ23950	< .1 B	.1 B	< .1 B	.7 B	< .06
07/21/86	SJ25339	< .1	.2	< .1	.1	< .07
09/15/86	SJ26963	< .1	.8	< .1	< .1	< .07
11/10/86	SJ28485	< .1	< .1	< .1	.1	< .06
01/20/87	SJ30660	< .1	< .1	< .1	< .1	< .06
03/16/87	SJ32246	< .06	< .06	< .06	< .06	< .04

FOOTNOTE(S) :

B - AVERAGE OF DUPS
D - RETESTED
M - UNIT = MPN/G

TABLE C14   SITE: IV-B-1

SAMPLE TEST RESULTS

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
04/21/86	SJ23134	49.6	8.273	7.627	6.967	10.165	8.948	5.726	5.799
06/16/86	SJ24508	55.4	7.890	7.618	5.734	9.924	8.143	6.908	7.230
08/11/86	SJ25998	47.0	7.690	6.690	4.919	9.959	9.230	6.431	6.362
10/06/86	SJ27453	59.6	9.255	8.602	5.813	9.301 D	8.301 D	5.415	5.690
12/08/86	SJ29392	62.7	7.380	6.839	5.568	9.431	9.079	4.505	6.732
02/09/87	SJ31375	51.9	8.225	6.462	5.462	9.415	8.519	5.544	5.724

SAMPLE TEST RESULTS

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	YERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
04/21/86	SJ23134	4.079	< .8	9.849	< .2	< 1	4200	1.3	1
06/16/86	SJ24508	4.462	< .7	9.173	170	< 1	< .2	< .1	< .1
08/11/86	SJ25998	3.041	< .8	8.924	< .2	< 1	< .2	.2	< .2
10/06/86	SJ27453	2.623	< .7	8.699 D	< .2	< 1	< .2	.4	.4
12/08/86	SJ29392	< 1.301	< .6	9.000	370000	< 1	< .2	< .1	< .1
02/09/87	SJ31375	4.653 D	< .8	8.996	.8	< 1	1	< .1	< .1

SAMPLE TEST RESULTS

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
04/21/86	SJ23134	< .1	.3	< .1	< .1	< .06
06/16/86	SJ24508	< .1	< .1	< .1	< .1	< .06
08/11/86	SJ25998	< .2	.2	< .2	< .2	< .08
10/06/86	SJ27453	< .1	< .1	< .1	< .1	< .06
12/08/86	SJ29392	< .1	< .1	< .1	< .1	< .05
02/09/87	SJ31375	< .1	< .1	< .1	< .1	< .07

FOOTNOTE(S) :

D - RETESTED

TABLE C15 SITE: IV-D-1

SAMPLE TEST RESULTS

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
05/29/86	SJ23951	83.8	3.045	1.253	.438	7.657 D	7.297 D	4.229	4.197
07/24/86	SJ25340	84.2	.436	.029	.708	7.128	5.593	< .903	< .903
09/17/86	SJ26961	91.1	1.204	1.204	2.398	7.230 D	5.146 D	4.322	4.041
11/12/86	SJ28484	78.2 B	4.491	1.462	4.491	8.079	6.204	4.740	3.301
02/09/87	SJ31373	85.0	3.041	2.708	3.431	8.544	7.230	3.255	2.839
03/27/87	SJ32456	83.4	3.244 B	2.105 B	1.716 B	8.483 B,D	6.142 B,D	2.602	2.699

SAMPLE TEST RESULTS

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	VERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
05/29/86	SJ23951	< 1.079	< .5	6.070	< .1	< 1	< .1	.5	.2
07/24/86	SJ25340	< 1.000	< .5	6.104	< .1	< 1	< .1	.2	< .09
09/17/86	SJ26961	< 1.000	.4	5.176 D	< .1	< 1	< .1	.2	< .06
11/12/86	SJ28484	1.000	< .5	6.681	< .1	< 1	< .1	.6	.3
02/09/87	SJ31373	< 1.000	< .5	6.778	< .1	< 1	< .1	.09	< .09
03/27/87	SJ32456	< 1.000 B	< .5 B	6.834 B	< .1 B	< 1 B	< .1 B	.3 B	.2 B

SAMPLE TEST RESULTS

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
05/29/86	SJ23951	< .1	.3	< .1	< .1	< .05
07/24/86	SJ25340	< .09	.2	< .09	< .09	< .04
09/17/86	SJ26961	< .06	.2	< .06	< .06	< .04
11/12/86	SJ28484	< .1	.2	.1	< .1	< .05
02/09/87	SJ31373	< .09	.09	< .09	< .09	< .05
03/27/87	SJ32456	< .05 B	.1 B	< .05 B	< .05 B	< .05

FOOTNOTE(S) :

B - AVERAGE OF DUPS
D - RETESTED

TABLE C16 SITE: IV-F-1

SAMPLE TEST RESULTS

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
06/02/86	SJ24279	19.2	8.350	7.685	6.039	9.732 D	9.495 D	> 6.319	4.656
07/15/86	SJ25187	87.1	6.651	6.028	5.693	8.688	7.177	2.991	4.653
09/15/86	SJ26962	17.2	7.565 B	6.065 B	4.171 B,D	9.500 B	8.369 B	6.431 B	< 1.602 B
11/19/86	SJ29035	28.7	7.903	6.415	5.505	8.792	8.279	6.255	2.863
01/21/87	SJ30661	32.2	5.851	5.462	4.813	8.991	8.000	5.531	3.146
03/09/87	SJ32247	87.3	6.415	5.041	3.230	8.477	3.000	< .903	< .903

SAMPLE TEST RESULTS

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	YERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
06/02/86	SJ24279	2.301	6.3	9.407	2200	< 1	< .5	130	130
07/15/86	SJ25187	< 1.000	< .5	7.167	< .1	< 1	< .1	.3	.2
09/15/86	SJ26962	2.088 B	< 2 B	8.447 B	< .6 B,D	< 1 B	< .6 B	50 B	50 B
11/19/86	SJ29035	< 1.477	< 1	7.875	< .3	< 1	< .3	2.2	2
01/21/87	SJ30661	2.531	< 1	7.380	71	< 1	< .3	< .2	< .2
03/09/87	SJ32247	2.322	< .5	7.176	< .1	< 1	< .1	< .06	< .06

SAMPLE TEST RESULTS

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
06/02/86	SJ24279	< .7	< .7	< .7	< .7	< .2
07/15/86	SJ25187	< .1	< .1	< .1	.1	< .05
09/15/86	SJ26962	< .3 B	< .3 B	< .3 B	< .3 B	< .2
11/19/86	SJ29035	< .2	< .2	< .2	.2	< .1
01/21/87	SJ30661	< .2	< .2	.2	< .2	< .1
03/09/87	SJ32247	< .06	< .06	< .06	< .06	< .05

FOOTNOTE(S) :

B - AVERAGE OF DUPS
D - RETESTED

TABLE C17 SITE IV-I-1

SAMPLE TEST RESULTS

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
05/05/86	SJ23582	97.5	.3 M	< .3 M	2.644	5.442 D	5.354 D	< .856	< .856
07/01/86	SJ24831	97.8	.643	.371	2.978	5.462	5.180	< .845	< .845
09/09/86	SJ26689	95.8	.477	< .3 M	1.987	5.255	5.279	< .845	< .845
11/04/86	SJ28415	97.8	4.672	4.672	5.041	6.114	5.973	1.602	< .845
01/15/87	SJ30493	94.0 B	1.380	1.380	2.663	6.740	6.000	< .845	< .845
02/25/87	SJ31634	97.3	1.176	< .3 M	4.643	5.279 D	5.398 D	1.301	1.477

SAMPLE TEST RESULTS

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	VERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
05/05/86	SJ23582	1.000	< .4	< 1.312 D	< .1	< 1	< .1	< .1	< .1
07/01/86	SJ24831	< 1.000	< .4	1.010	< .1	< 1	< .1	.1	.1
09/09/86	SJ26689	< 1.000	< .4	< 1.301	< .1	< 1	< .1	< .06	< .06
11/04/86	SJ28415	< 1.000	< .4	3.176 D	.4	< 1	< .1	< .06	< .06
01/15/87	SJ30493	< 1.000	< .4	2.591	< .1	< 1	< .1	.08	< .08
02/25/87	SJ31634	< 1.000	< .4	3.716	< .1	< 1	.1	.2	.2

SAMPLE TEST RESULTS

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
05/05/86	SJ23582	< .1	< .1	< .1	< .1	< .04
07/01/86	SJ24831	< .1	< .1	< .1	< .1	< .04
09/09/86	SJ26689	< .06	< .06	< .06	< .06	< .05
11/04/86	SJ28415	< .6	< .06	< .06	< .06	< .04
01/15/87	SJ30493	< .08	.08	< .08	< .08	< .04
02/25/87	SJ31634	< .08	< .08	< .08	< .08	< .04

FOOTNOTE(S) :

B - AVERAGE OF DUPS
D - RETESTED
M - UNIT = MPN/G

TABLE C18 SITE: V-B-1

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
04/29/86	SJ23314	39.1	3.770	3.770	2.584	8.085	6.806	4.738	4.567
06/18/86	SJ24680	49.8	4.271	3.936	2.664	8.387	6.726	4.602	4.041
08/19/86	SJ26175	77.5	4.079	3.740	2.477	8.643	7.959	4.544	4.462
10/08/86	SJ27455	52.2	4.914	3.255	2.643	8.892	6.146	4.146	4.079
12/12/86	SJ29593	50.5 B	4.929	2.929	.929	8.477 D	7.959 D	4.041	3.653
02/09/87	SJ31479	44.4	2.230	1.322	1.716	8.491 D	7.079 D	3.462	3.447

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	YERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
04/29/86	SJ23314	2.176	< 1	6.441	< .3	< 1	< .3	.4	.1
06/18/86	SJ24680	< 1.000	< .8	6.883	< .2	< 1	< .2	.8	.8
08/19/86	SJ26175	< 1.000	< .5	7.204	< .1	< 1	< .1	< .1	< .1
10/08/86	SJ27455	2.732	< .8	7.279	< .2	< 1	< .2	< .1	< .1
12/12/86	SJ29593	< 1.301	< .8	6.763	< .2	< 1	< .2	< .1	< .1
02/09/87	SJ31479	< 1.301	< .9	6.556	< .2	< 1	100	.8	.8

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
04/29/86	SJ23314	< .1	.3	< .1	< .1	< .09
06/18/86	SJ24680	< .2	< .2	< .2	< .2	< .08
08/19/86	SJ26175	< .1	< .1	< .1	< .1	< .05
10/08/86	SJ27455	< .1	< .1	< .1	< .1	< .07
12/12/86	SJ29593	< .1	< .1	< .1	< .1	< .07
02/09/87	SJ31479	< .2	< .2	< .2	< .2	< .08

FOOTNOTE(S) :

B - AVERAGE OF DUPS
D - RETESTED

TABLE C19 SITE: V-K-1

SAMPLE TEST RESULTS

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
04/21/86	SJ23135	40.0	7.366 D	7.366 D	8.778 D	9.995	9.614	1.398	< 1.243
06/17/86	SJ24509	47.9	4.288 D	3.953 D	6.288	10.518	7.992	< 1.000	< 1.000
08/19/86	SJ26177	52.2	4.643	.301	5.643	9.771	8.929	< 1.000	< 1.000
10/06/86	SJ27454	39.7	4.362	4.362	7.041	9.949 D	9.114 D	< 1.301	< 1.301
12/08/86	SJ29393	39.1	5.771	5.380	7.041	9.398	8.380	< 1.301	< 1.301
02/10/87	SJ31376	39.6	5.362	4.041	7.763	9.643	8.857	6.519	< 1.301

SAMPLE TEST RESULTS

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	YERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
04/21/86	SJ23135	1.699	< 1	9.279	110	< 1	< .2	1.7	1
06/17/86	SJ24509	1.602	< .8	7.963	3.1	< 1	< .6	.8	.5
08/19/86	SJ26177	< 1.301	< .8	8.799	18	< 1	< .2	8	3
10/06/86	SJ27454	< 1.477	< 1	8.653	3.8	< 1	< .3	11.1	1
12/08/86	SJ29393	1.699	< 1	7.813	24	< 1	1	< .2	< .2
02/10/87	SJ31376	< 1.477	< 1	7.204	< .3	< 1	< .3	3	3

SAMPLE TEST RESULTS

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
04/21/86	SJ23135	< .2	.7	< .2	< .2	< .09
06/17/86	SJ24509	< .1	.3	< .1	< .1	< .09
08/19/86	SJ26177	< .1	5	< .1	< .1	< .07
10/06/86	SJ27454	< .1	10	< .1	.1	< .08
12/08/86	SJ29393	< .2	< .2	< .2	< .2	< .1
02/10/87	SJ31376	< .2	< .2	< .2	< .2	< .1

FOOTNOTE(S) :

D - RETESTED

TABLE C20 SITE: VI-D-1

SAMPLE TEST RESULTS

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
05/12/86	SJ23710	68.2	1.528	< .4 M	1.528	7.829	6.342	4.041	2.421
07/07/86	SJ24988	67.1	1.807	1.807	3.495 D	8.063	6.650	4.398	4.079
09/08/86	SJ26687	67.4	5.204	2.342	4.556 D	7.613	7.279	4.301	2.491
10/29/86	SJ28168	80.1 B	5.477	1.079	3.079	7.230	6.778	3.000	2.653
01/08/87	SJ30415	68.5	3.799	2.342	< .4 D,M	7.230	6.708	4.000	3.672
02/23/87	SJ31794	69.3	2.114	.000	.6 M	7.699	6.806	3.663	3.580

SAMPLE TEST RESULTS

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	YERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
05/12/86	SJ23710	1.771	< .6	6.838	< .2	< 1	< .2	< .1	< .1
07/07/86	SJ24988	< 1.000	< .6	6.194	< .2	< 1	< .2	.1	< .1
09/08/86	SJ26687	< 1.000	< .6	6.114	< .1	< 1	< .1	< .08	< .08
10/29/86	SJ28168	< 1.000	< .5	6.114	< .1	< 1	< .1	< .07	< .07
01/08/87	SJ30415	< 1.000	< .6	5.820	< .1	< 1	< .1	< .08	< .08
02/23/87	SJ31794	< 1.000	< .6	5.279	< .1	< 1	< .1	< .1	< .1

SAMPLE TEST RESULTS

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
05/12/86	SJ23710	< .1	< .1	< .1	< .1	< .06
07/07/86	SJ24988	< .1	< .1	< .1	.1	< .06
09/08/86	SJ26687	< .08	< .08	< .08	< .08	< .06
10/29/86	SJ28168	< .07	< .07	< .07	< .07	< .06
01/08/87	SJ30415	< .08	< .08	< .08	< .08	< .06
02/23/87	SJ31794	< .1	< .1	< .1	< .1	< .06

FOOTNOTE(S) :

B - AVERAGE OF DUPS
D - RETESTED
M - UNIT = MPN/G

TABLE C21 SITE: VII-D-1

SAMPLE TEST RESULTS

DATE	LOG NO.	TOTAL SOLIDS	TOTAL COLIFORM	FECAL COLIFORM	FECAL STREP	AEROBIC PLATE COUNT	ANAEROBIC PLATE COUNT	TOTAL FUNGI	THERMOPHILIC FUNGI
		%	LOGMPN/G	LOGMPN/G	LOGMPN/G	LOGCFU/G	LOGCFU/G	LOGCFU/G	LOGCFU/G
05/16/86	SJ23839	67.9	2.344	2.043	.802	7.916	6.680	4.708	4.932
08/05/86	SJ25801	77.5	3.740	3.740	3.079	8.531 D	6.591 D	5.279	5.230
09/09/86	SJ26685	68.6	3.146	2.146	1.799	7.041	6.204	> 4.740	4.176
11/20/86	SJ29383	39.1	< .8 M	< .8 M	1.708	6.041	5.398	< 1.301	< 1.301
01/13/87	SJ30494	81.5	.5 M	.5 M	.447	5.491	5.079	< .954	< .954
03/09/87	SJ32196	92.9	< .3	< .3 M	< .3 M	5.146 D	4.580 B	< .903	< .903

SAMPLE TEST RESULTS

DATE	LOG NO.	COLIPHAGE	TOXIGENIC E. COLI	TOTAL ENTERIC BACTERIA	SALMONELLA	CAMPYLOBACTER	YERSINIA	TOTAL PARASITES	TOTAL ASCARIS
		LOGPFU/G	MPN/G	LOGCFU/G	MPN/G	ISOLATE	MPN/G	O&C/G	OVA/G
05/16/86	SJ23839	3.176	< .6	7.254	< .2	< 1	< .2	.9	.5
08/05/86	SJ25801	< 1.000	< .5	4.845 D	< .1	< 1	< .1	.5	< .1
09/09/86	SJ26685	< 1.000	< .6	5.380 D	< .1	< 1	< .1	.36	.2
11/20/86	SJ29383	< 1.477	< 1	< 1.477	< .3	< 1	< .3	.3	.3
01/13/87	SJ30494	< 1.000	< .5	< 1.000	< .1	< 1	< .1	.09	< .09
03/09/87	SJ32196	< 1.000	< .4	< 1.000	< .1	< 1	< .1	< .08	< .08

SAMPLE TEST RESULTS

DATE	LOG NO.	VIABLE ASCARIS	TRICHURIS	HYMENOLEPIS	TOXOCARA	TOTAL ENTERIC VIRUSES
		OVA/G	OVA/G	OVA/G	OVA/G	I.U./G
05/16/86	SJ23839	< .1	.2	< .1	.2	< .05
08/05/86	SJ25801	< .1	.3	< .1	.2	< .04
09/09/86	SJ26685	< .08	.08	.08	< .08	< .06
11/20/86	SJ29383	< .1	< .1	< .1	< .1	< .1
01/13/87	SJ30494	< .09	< .09	.09	< .09	< .04
03/09/87	SJ32196	< .08	< .08	< .08	< .08	< .04

FOOTNOTE(S) :

B - AVERAGE OF DUPS
D - RETESTED
M - UNIT = MPN/G

TABLE C22 SITE: VII-A-2

SAMPLE TEST RESULTS

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
05/19/86	SJ23840	55.7	4.223	3.576	3.129	8.586	6.816	4.444	3.634
07/14/86	SJ25185	57.9	2.413	1.317	1.413 D	7.794 D	7.107 D	< 1.000	< 1.000
09/09/86	SJ26686	54.9	1.230	< .5 M	.301	8.398	5.079	2.431	2.000
11/03/86	SJ28416	50.9	1.653	.000	1.653	8.176 D	6.875 D	2.000	2.342
01/12/87	SJ30495	54.1	1.898	.415	2.898	8.301 D	7.322 D	3.491	3.732
03/09/87	SJ32195	49.4	.477	< .6 M	1.477	8.041	6.903	3.079	3.079

SAMPLE TEST RESULTS

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	YERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
05/19/86	SJ23840	1.255	< .7	7.733	< .2	< 1	2.7 D	.3	< .1
07/14/86	SJ25185	< 1.301	< .7	6.082	< .2	< 1	< .2	.5	.1
09/09/86	SJ26686	< 1.301	< .7	7.279	< .2	< 1	< .2	.5	.1
11/03/86	SJ28416	< 1.301	< .8	6.398	< .2	< 1	< .2	< .1	< .1
01/12/87	SJ30495	< 1.000	< .7	7.633	< .2	< 1	< .2	< .1	< .1
03/09/87	SJ32195	< 1.301	< .8	7.041	< .2	< 1	< .2	< .1	< .1

SAMPLE TEST RESULTS

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
05/19/86	SJ23840	< .1	.3	< .1	< .1	< .07
07/14/86	SJ25185	< .1	< .1	< .1	.4	< .07
09/09/86	SJ26686	< .1	< .1	.4	< .1	< .07
11/03/86	SJ28416	< .1	< .1	< .1	< .1	< .07
01/12/87	SJ30495	< .1	< .1	< .1	< .1	< .09
03/09/87	SJ32195	< .1	< .1	< .1	< .1	< .08

FOOTNOTE(S) :

D - RETESTED
M - UNIT = MPN/G

TABLE C23 SITE: VIII-D-1

* SAMPLE TEST RESULTS *

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
05/05/86	SJ23581	71.9	7.777 D	7.777 D	5.112	9.226	8.895	1.842	.988
06/30/86	SJ24832	59.6	6.858	6.193	4.858	9.827	8.550	4.869	2.643
08/25/86	SJ26352	67.6	6.342	5.531	6.342	9.255	7.301	4.462	4.322
10/20/86	SJ27950	49.1	6.279	6.279	4.176	9.415	7.929	4.462	5.398
12/29/86	SJ30406	34.3	5.638 B,D	3.735 B,D	3.887 B,D	9.509 B	7.389 B	4.279 B	4.462 B
02/23/87	SJ31635	19.8	4.672	3.342	3.881	10.176	8.176	2.000	< 1.602

* SAMPLE TEST RESULTS *

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	YERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
05/05/86	SJ23581	2.322	< .6	8.751	1	< 1	3.9 D	< .1	< .1
06/30/86	SJ24832	2.839	< .7	9.218	390	< 1	< .2	.3	.1
08/25/86	SJ26352	2.949	< .6	8.041	64	< 1	< .1	.2	.2
10/20/86	SJ27950	3.146	< .8	8.380	2	< 1	< .2	.5	< .2
12/29/86	SJ30406	2.540 B	< 1 B	8.332 B	< .3 B	< 1 B	< .3 B	< .1 B	< .1 B
02/23/87	SJ31635	4.255	< 2	8.362 D	< .5	< 1	.5	< .4	< .4

* SAMPLE TEST RESULTS *

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
05/05/86	SJ23581	< .1	< .1	< .1	< .1	< .05
06/30/86	SJ24832	< .1	< .1	< .1	.2	< .06
08/25/86	SJ26352	< .08	< .08	< .08	< .08	< .05
10/20/86	SJ27950	< .2	< .2	< .2	.5	< .07
12/29/86	SJ30406	< .1 B	< .1 B	< .1 B	< .1 B	< .1
02/23/87	SJ31635	< .4	< .4	< .4	< .4	< .2

FOOTNOTE(S) :

B - AVERAGE OF DUPS
D - RETESTED

TABLE C24 SITE: VIII-F-1

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
05/12/86	SJ23711	50.0	4.964	2.663	3.477	8.380 D	7.471 D	4.086	< 1.146
07/10/86	SJ24990	62.6	4.837 D	1.408 D	5.565	8.434	7.120	3.279	2.982
09/02/86	SJ26591	81.7	.415	< .4 M	2.724	7.908	6.959	2.519	< 1.000
10/29/86	SJ28169	74.8	4.301	< .4 M	4.447	8.708	6.279	5.204	1.602
01/07/87	SJ30416	61.2	5.384 B	.580 B	4.712 B	9.019 B	6.462 B	5.146 B	4.041 B
03/03/87	SJ31795	67.6	2.647 B	< .4 B,M	2.031 B	8.406 B,D	6.618 B,D	3.839 B	< 1.000 B

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	YERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
05/12/86	SJ23711	2.000	< .8	7.504	< .2	< 1	1	.8	.5
07/10/86	SJ24990	3.146	< .6	7.454 D	< .2	< 1	< .2	< .1	< .1
09/02/86	SJ26591	< 1.000	< .5	7.903 D	< .1	< 1	< .1	< .09	< .09
10/29/86	SJ28169	< 1.000	< .5	7.398	< .1	< 1	< .1	< .07	< .07
01/07/87	SJ30416	2.597 B	< .6 B	8.146 B	< .2 B	< 1 B	< .2 B	.1 B	.1 B
03/03/87	SJ31795	< 1.000 B	< .6 B	6.952 B	< .1 B	< 1 B	< .1 B	.08 B	.08 B

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
05/12/86	SJ23711	< .1	.1	< .1	.2	< .07
07/10/86	SJ24990	< .1	< .1	< .1	< .1	< .06
09/02/86	SJ26591	< .09	< .09	< .09	< .09	< .05
10/29/86	SJ28169	< .07	< .07	< .07	< .07	< .05
01/07/87	SJ30416	< .5 B	< .05 B	< .05 B	< .05 B	< .07
03/03/87	SJ31795	< .05 B	< .05 B	< .05 B	< .05 B	< .06

FOOTNOTE(S) :

B - AVERAGE OF DUPS
D - RETESTED
M - UNIT = MPN/G

TABLE C25 SITE VIII-H-1

* SAMPLE TEST RESULTS *

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
04/09/86	SJ22933	36.9	3.795	1.609	.795	8.265	6.813	3.505	4.063
06/12/86	SJ24506	38.3	1.779 D	1.385 D	2.050	8.161	7.690	4.672	3.398
08/04/86	SJ25799	55.5	5.886	5.431	3.230	8.519	8.114	4.279	3.875
09/29/86	SJ27471	40.7	5.041	2.362	4.771	8.886	6.398	< 1.301	< 1.301
12/01/86	SJ29380	38.6 B	2.491	1.041	.778	8.204 D	7.531 D	3.724	4.079
02/02/87	SJ31159	30.9	3.477	< .000	< .000	8.301	7.792	3.681	4.322

* SAMPLE TEST RESULTS *

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	YERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
04/09/86	SJ22933	< 1.431	< 1	7.505	< .3	< 1	< .3	< .2	< .2
06/12/86	SJ24506	< 1.477	< 1	6.667	< .3	< 1	< .3	< .2	< .2
08/04/86	SJ25799	< 1.301	< .7	7.415	< .2	< 1	< .2	.4	.1
09/29/86	SJ27471	< 1.301	< 1	8.462	1	< 1	< .2	.9	< .2
12/01/86	SJ29380	< 1.477	< 1	8.079	< .3	< 1	< .3	< .1	< .1
02/02/87	SJ31159	< 1.477	< 1	7.491	< .3	< 1	< .3	< .2	< .2

* SAMPLE TEST RESULTS *

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
04/09/86	SJ22933	< .2	< .2	< .2	< .2	< .1
06/12/86	SJ24506	< .2	< .2	< .2	< .2	< .09
08/04/86	SJ25799	< .1	< .1	< .1	.3	< .06
09/29/86	SJ27471	< .2	.9	< .2	< .2	< .09
12/01/86	SJ29380	< .1	< .1	< .1	< .1	< .05
02/02/87	SJ31159	< .2	< .2	< .2	< .2	< .1

FOOTNOTE(S) :

B - AVERAGE OF DUPS
D - RETESTED

TABLE C26 SITE VIII-J-1

* SAMPLE TEST RESULTS *

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
04/07/86	SJ22611	64.2	< .5 M	< .5 M	< .5 M	7.711	4.467	< 1.038	< 1.038
06/06/86	SJ24105	76.5	1.085	.750	2.085	6.729 D	4.807 D	2.255	2.322
07/28/86	SJ25579	78.7	.426	< .4 M	.8 M	7.405	5.678	< .954	< .954
09/22/86	SJ27110	62.0	4.568 D	4.568 D	5.568 D	9.079	8.041	4.602	3.342
11/24/86	SJ29032	64.6	4.556	4.556	4.146	9.146	5.556	3.771	3.681
01/27/87	SJ30824	37.6	4.785	2.398	3.785 D	9.342	8.699	5.380	3.079

* SAMPLE TEST RESULTS *

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	YERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
04/07/86	SJ22611	1.672	< .6	2.971	< .2	< 1	< .2	.2	.1
06/06/86	SJ24105	< 1.000	< .5	5.473	< .1	< 1	< .1	.3	.2
07/28/86	SJ25579	< 1.000	< .5	6.168	< .1	< 1	< .1	< .09	< .09
09/22/86	SJ27110	< 1.301	< .6	7.806	< .2	< 1	< .2	< .1	< .1
11/24/86	SJ29032	1.602	< .7	8.322	< .2	< 1	< .2	.1	< .1
01/27/87	SJ30824	< 1.477	< 1	8.146	< .3	< 1	< .3	.2	< .2

* SAMPLE TEST RESULTS *

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
04/07/86	SJ22611	< .1	.1	< .1	< .1	< .06
06/06/86	SJ24105	< .1	.1	< .1	< .1	< .04
07/28/86	SJ25579	< .09	< .09	< .09	< .09	< .06
09/22/86	SJ27110	< .1	< .1	< .1	< .1	< .05
11/24/86	SJ29032	< .1	.1	< .1	< .1	< .06
01/27/87	SJ30824	< .2	.2	< .2	< .2	< .1

FOOTNOTE(S) :

D - RETESTED
M - UNIT = MPN/G

TABLE C27 SITE: IX-A-10

SAMPLE TEST RESULTS

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
04/14/86	SJ22934	38.7	4.381	2.774	4.046	9.111	8.998	2.944	3.264
06/09/86	SJ24280	32.9	3.845	3.116	5.116	9.182 D	8.721 D	3.204	2.716
08/04/86	SJ25800	39.1	1.580	1.380	2.771	8.477	8.204	< 1.301	< 1.301
09/29/86	SJ27472	41.1	3.708	< .7 M	1.748 D	8.204	7.342	1.301	1.301
12/01/86	SJ29381	49.3	6.176	4.940	3.898	8.362 D	7.806 D	< 1.000	< 1.000
02/02/87	SJ31160	37.1	1.341 B,D	< .8 B,D,M	.301 B	8.552 B	7.878 B	< 1.301 B	< 1.301 B

SAMPLE TEST RESULTS

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	YERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
04/14/86	SJ22934	1.415	< 1	7.371	< .3	< 1	< .3	.2	.2
06/09/86	SJ24280	< 1.477	< 1	7.410 D	< .3	< 1	< .3	.2	< .2
08/04/86	SJ25800	< 1.477	< 1	8.146	< .3	< 1	< .3	.9	.2
09/29/86	SJ27472	< 1.301	< 1	7.342	< .2	< 1	< .2	< .2	< .2
12/01/86	SJ29381	1.301	< .8	8.602	< .2	< 1	< .2	.2	.1
02/02/87	SJ31160	< 1.477 B,D	< 1 B	8.455 B	< .3 B	< 1 B	< .3 B	.4 B	< .1 B

SAMPLE TEST RESULTS

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
04/14/86	SJ22934	< .2	< .2	< .2	< .2	< .08
06/09/86	SJ24280	< .2	.2	< .2	< .2	< .09
08/04/86	SJ25800	< .2	< .2	< .2	.7	< .07
09/29/86	SJ27472	< .2	< .2	< .2	< .2	< .08
12/01/86	SJ29381	< .1	< .1	< .1	.1	< .06
02/02/87	SJ31160	< .1 B	.4 B	< .1 B	< .1 B	< .09

FOOTNOTE(S) :

B - AVERAGE OF DUPS
D - RETESTED
M - UNIT = MPN/G

TABLE C28 SITE: IX-B-1

SAMPLE TEST RESULTS

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
04/07/86	SJ22610	53.5	6.934	6.934	5.863	9.020	7.332	5.611	5.480
06/02/86	SJ24106	53.4 B	6.069 B	5.069 B	3.271 B	9.021 D	6.853 D	5.934 B	6.041 B
07/28/86	SJ25580	59.7	7.586	7.193	4.671	9.987	8.312	6.114	6.785
09/22/86	SJ27111	84.4	8.708 D	6.949 D	6.740	9.301	8.748	5.663	5.771
11/24/86	SJ29033	60.4	6.398	4.851	5.176	9.362 D	9.279 D	4.462	4.505
01/26/87	SJ30822	54.3	6.898	5.447	5.927 B	9.959	9.255	5.613 B	5.699 B

SAMPLE TEST RESULTS

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	VERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
04/07/86	SJ22610	1.568	< .8	8.088	.6	< 1	.6	1.0	.7
06/02/86	SJ24106	1.628 B	< .7	7.590 B	< .2 B	< 1	< .2 B	2.3 B	2 B
07/28/86	SJ25580	4.322	< .7	9.133	< .2	< 1	< .1	1.3	.5
09/22/86	SJ27111	1.602	1.4	8.342	< .1 D	< 1	< .1	< .1	< .1
11/24/86	SJ29033	1.301	< .7	8.279	< .2	< 1	< .2	< .1	< .1
01/26/87	SJ30822	2.000 B	< .7 B	8.763	< .2 B	< 1 B	.4 B	.2	< .2

SAMPLE TEST RESULTS

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
04/07/86	SJ22610	< .1	.3	< .1	< .1	< .07
06/02/86	SJ24106	< .08 B	.3 B	< .08 B	< .08 B	< .06 B
07/28/86	SJ25580	< .1	.5	.1	.2	< .06
09/22/86	SJ27111	< .1	< .1	< .1	< .1	< .04
11/24/86	SJ29033	< .1	< .1	< .1	< .1	< .06
01/26/87	SJ30822	< .2	.2	< .2	< .2	< .07 B

FOOTNOTE(S) :

B - AVERAGE OF DUPS
D - RETESTED

TABLE C29 SITE: IX-D-1

SAMPLE TEST RESULTS

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
04/07/86	SJ22612	61.4	2.388	< .5 M	< .5 M	8.287	4.898 D	< 1.057	< 1.057
06/02/86	SJ24107	71.2	2.781	.781	1.509	8.287	6.957	< 1.000	< 1.000
07/28/86	SJ25578	73.1	2.770	< .4 M	< .4 M	8.011	7.551	< 1.000	< 1.000
09/22/86	SJ27112	71.2	5.505 B	3.642 B	3.414 B	8.602 B	6.012 B	< 1.000 B	< 1.000 B
11/24/86	SJ29034	81.5	6.415	2.681	3.041	7.732	6.681	< .954	< .954
01/26/87	SJ30823	77.0	.716	< .4 M	< .4 M	7.613	5.785	5.114	< .954

SAMPLE TEST RESULTS

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	YERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
04/07/86	SJ22612	2.518	< .6	8.787	< .2	< 1	< .2	3.3	1
06/02/86	SJ24107	1.000	< .6	7.755	< .1	< 1	< .1	3.2	2
07/28/86	SJ25578	< 1.000	< .6	7.478	< .1	< 1	< .2	1.6	1
09/22/86	SJ27112	1.452 B	< .6 B	8.423 B	140 B	< 1 B	< .1 B	3.7 B	3 B
11/24/86	SJ29034	< 1.000	< .5	7.699	< .1	< 1	< .1	.54	.4
01/26/87	SJ30823	< 1.000	< .5	6.881	< .1	< 1	< .1	1	.8

SAMPLE TEST RESULTS

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
04/07/86	SJ22612	< .1	2	< .1	.3	< .06
06/02/86	SJ24107	< .1	1	< .1	.2	< .05
07/28/86	SJ25578	< .1	.5	< .1	.1	< .05
09/22/86	SJ27112	< .05 B	.4 B	< .05 B	.3 B	< .05
11/24/86	SJ29034	< .07	.07	< .07	.07	< .06
01/26/87	SJ30823	< .1	.1	< .1	.1	< .05

FOOTNOTE(S) :

B - AVERAGE OF DUPS
D - RETESTED
M - UNIT = MPN/G

TABLE C30 SITE: IX-D-2

* SAMPLE TEST RESULTS *

DATE	LOG NO.	TOTAL SOLIDS	TOTAL COLIFORM	FECAL COLIFORM	FECAL STREP	AEROBIC PLATE COUNT	ANAEROBIC PLATE COUNT	TOTAL FUNGI	THERMOPHILIC FUNGI
		%	LOGMPN/G	LOGMPN/G	LOGMPN/G	LOGCFU/G	LOGCFU/G	LOGCFU/G	LOGCFU/G
04/22/86	SJ23136	44.4	2.675 D	1.714 D	.675 D	8.557	7.236	2.884	3.800
06/09/86	SJ24281	93.8	3.329 B	.3 B,M	.137 B	7.439 B	5.491 B	5.505 B	2.857 B
07/23/86	SJ25581	86.5	6.031 B	4.654 B	1.938	9.092	6.547	2.505	1.954
10/14/86	SJ27756	90.0	6.681	6.415	3.681	8.204	6.505	3.653	4.146
11/21/86	SJ29382	91.4	2.505	.4 M	.000	7.000 D	6.079 D	4.556	< .903
01/29/87	SJ31161	80.9	.724	< .4 M	4.176	8.505	8.380	5.663	< .954

* SAMPLE TEST RESULTS *

DATE	LOG NO.	COLIPHAGE	TOXIGENIC E. COLI	TOTAL ENTERIC BACTERIA	SALMONELLA	CAMPYLOBACTER	VERSINIA	TOTAL PARASITES	TOTAL ASCARIS
		LOGPFU/G	MPN/G	LOGCFU/G	MPN/G	ISOLATE	MPN/G	O&C/G	OVA/G
04/22/86	SJ23136	3.979	< .9	7.837	< .2	< 1	< .2	< .2	< .2
06/09/86	SJ24281	< 1.000 B	< .4 B	5.825 B	< .1 B	< 1 B	< .1 B	< .04 B	< .04 B
07/23/86	SJ25581	< 1.000	< .5	7.027	500	< 1	< .2	< .08	< .08
10/14/86	SJ27756	< 1.000	< .4	6.869	.1	< 1	< .1	< .08	< .08
11/21/86	SJ29382	< 1.000	< .4	4.301 D	< .1	< 1	< .1	< .08	< .08
01/29/87	SJ31161	< 1.000	< .5	5.531 D	< .1	< 1	< .1	< .09	< .09

* SAMPLE TEST RESULTS *

DATE	LOG NO.	VIABLE ASCARIS	TRICHURIS	HYMENOLEPIS	TOXOCARA	TOTAL ENTERIC VIRUSES
		OVA/G	OVA/G	OVA/G	OVA/G	I.U./G
04/22/86	SJ23136	< .2	< .2	< .2	< .2	< .07
06/09/86	SJ24281	< .04 B	< .04 B	< .04 B	< .04 B	< .04 B
07/23/86	SJ25581	< .08	< .08	< .08	< .08	< .04
10/14/86	SJ27756	< .08	< .08	< .08	< .08	< .05
11/21/86	SJ29382	< .08	< .08	< .08	< .08	< .04
01/29/87	SJ31161	< .09	< .09	< .09	< .09	< .05

FOOTNOTE(S) :

B - AVERAGE OF DUPS
D - RETESTED
M - UNIT = MPN/G

TABLE C31 SITE: IX-D-3

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
05/15/86	SJ23712	96.4	3.378	2.220	.891	8.870	7.596	5.701	5.507
07/09/86	SJ24989	86.0	2.699	.020	1.388	8.222	7.202	5.041	5.447
09/02/86	SJ26590	76.1	3.616 B,D	3.116 B,D	2.977 B	8.289 B	7.846 B	5.301 B	5.322 B
10/27/86	SJ28170	87.1	4.041	3.041	2.380	7.380 D	5.079 D	4.301	4.342
01/12/87	SJ30496	89.7	4.633	2.362	< .3 M	8.431	7.663	5.079	4.851
02/13/87	SJ31480	82.1 B	< .4 B,M	< .4 B,M	.703 B	7.644 B	5.388 B	< .954 B	< .954 B

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	YERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
05/15/86	SJ23712	< 1.000	< .4	6.596	.1	< 1	< .1	< .05	< .05
07/09/86	SJ24989	< 1.000	< .5	5.773	< .1	< 1	< .1	.1	< .1
09/02/86	SJ26590	< 1.000 B	< .5 B	7.241 B	2 B	< 1 B	< .1 B	.6 B	.3 B
10/27/86	SJ28170	< 1.000	< .5	7.041	17	< 1	< .1	< .06	< .06
01/12/87	SJ30496	< 1.301	< .4	7.322	48	< 1	< .1	< .08	< .08
02/13/87	SJ31480	< 1.000 B	< .5 B	2.473 B	< .1 B	< 1 B	< .1 B	< .05 B	< .05 B

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
05/15/86	SJ23712	< .05	< .05	< .05	< .05	< .04
07/09/86	SJ24989	< .1	.1	< .1	< .1	< .04
09/02/86	SJ26590	< .05 B	.3 B	< .05 B	< .05 B	< .05 B
10/27/86	SJ28170	< .06	< .06	< .06	< .06	< .05
01/12/87	SJ30496	< .08	< .08	< .08	< .08	< .04
02/13/87	SJ31480	< .05 B	< .05 B	< .05 B	< .05 B	< .05

FOOTNOTE(S) :

B - AVERAGE OF DUPS
D - RETESTED
M - UNIT = MPN/G

TABLE C32 SITE: X-C-1

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	TOTAL SOLIDS %	TOTAL COLIFORM LOGMPN/G	FECAL COLIFORM LOGMPN/G	FECAL STREP LOGMPN/G	AEROBIC PLATE COUNT LOGCFU/G	ANAEROBIC PLATE COUNT LOGCFU/G	TOTAL FUNGI LOGCFU/G	THERMOPHILIC FUNGI LOGCFU/G
05/19/86	SJ23841	38.3	3.879	3.292	3.050	7.780	5.769	< 1.262	2.417
07/14/86	SJ25186	42.2	3.697 D	.329 D	4.008	9.336	8.559	< 1.301	< 1.301
09/08/86	SJ26688	57.4	8.114 D	7.114 D	6.415 D	9.204	7.771	3.279	3.230
10/31/86	SJ28417	36.5	4.799	4.398	4.833	8.681 D	8.833 D	3.663	3.653
01/12/87	SJ30497	32.6	5.114	4.462	3.851	9.204	8.602	3.851	2.763
03/09/87	SJ32194	43.5	5.659 B	.6 B,M	1.523 B,D	9.311 B	7.899 B	< 1.301	< 1.301

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	COLIPHAGE LOGPFU/G	TOXIGENIC E. COLI MPN/G	TOTAL ENTERIC BACTERIA LOGCFU/G	SALMONELLA MPN/G	CAMPYLOBACTER ISOLATE	YERSINIA MPN/G	TOTAL PARASITES O&C/G	TOTAL ASCARIS OVA/G
05/19/86	SJ23841	1.892	< 1	6.176	< .3	< 1	< .3	.8	< .1
07/14/86	SJ25186	< 1.301	< 1	8.954	< .2	< 1	< .2	1.1	.4
09/08/86	SJ26688	< 1.301	< .7	8.748	.2	< 1	< .2	.4	< .09
10/31/86	SJ28417	2.431	< 1	7.633	< .3	< 1	< .3	.2	< .2
01/12/87	SJ30497	< 1.477	< 1	8.531	< .3	< 1	< .3	.2	< .2
03/09/87	SJ32194	< 1.301 B,D	< .9 B	8.998 B	< .2 B	< 1 B	52 B	1 B	< .1 B

* SAMPLE TEST RESULTS * * * * * * * * * * * * * * * * * * *

DATE	LOG NO.	VIABLE ASCARIS OVA/G	TRICHURIS OVA/G	HYMENOLEPIS OVA/G	TOXOCARA OVA/G	TOTAL ENTERIC VIRUSES I.U./G
05/19/86	SJ23841	< .1	.8	< .1	< .1	< .08
07/14/86	SJ25186	< .2	.7	< .2	< .2	< .08
09/08/86	SJ26688	< .09	.4	< .09	< .09	< .07
10/31/86	SJ28417	< .2	.2	< .2	< .2	< .09
01/12/87	SJ30497	< .2	.2	< .2	< .2	< .1
03/09/87	SJ32194	< .1 B	1 B	< .1 B	< .1 B	< .08

FOOTNOTE(S) :

B - AVERAGE OF DUPS
D - RETESTED
M - UNIT = MPN/G